

1981

An Instructional Sequence in Experimental Design and Statistics for Graduate Music Therapy Students.

Anthony Arthur Decuir

Louisiana State University and Agricultural & Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_disstheses

Recommended Citation

Decuir, Anthony Arthur, "An Instructional Sequence in Experimental Design and Statistics for Graduate Music Therapy Students." (1981). *LSU Historical Dissertations and Theses*. 3677.
https://digitalcommons.lsu.edu/gradschool_disstheses/3677

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Historical Dissertations and Theses by an authorized administrator of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.

INFORMATION TO USERS

This was produced from a copy of a document sent to us for microfilming. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help you understand markings or notations which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure you of complete continuity.
2. When an image on the film is obliterated with a round black mark it is an indication that the film inspector noticed either blurred copy because of movement during exposure, or duplicate copy. Unless we meant to delete copyrighted materials that should not have been filmed, you will find a good image of the page in the adjacent frame. If copyrighted materials were deleted you will find a target note listing the pages in the adjacent frame.
3. When a map, drawing or chart, etc., is part of the material being photographed the photographer has followed a definite method in "sectioning" the material. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.
4. For any illustrations that cannot be reproduced satisfactorily by xerography, photographic prints can be purchased at additional cost and tipped into your xerographic copy. Requests can be made to our Dissertations Customer Services Department.
5. Some pages in any document may have indistinct print. In all cases we have filmed the best available copy.

University
Microfilms
International

300 N. ZEEB RD., ANN ARBOR, MI 48106

Decuir, Anthony Arthur

**AN INSTRUCTIONAL SEQUENCE IN EXPERIMENTAL DESIGN AND
STATISTICS FOR GRADUATE MUSIC THERAPY STUDENTS**

The Louisiana State University and Agricultural and Mechanical Col. **Ph.D. 1981**

**University
Microfilms
International** 300 N. Zeeb Road, Ann Arbor, MI 48106

Copyright 1982

by

Decuir, Anthony Arthur

All Rights Reserved

AN INSTRUCTIONAL SEQUENCE IN EXPERIMENTAL DESIGN
AND STATISTICS FOR GRADUATE MUSIC
THERAPY STUDENTS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The School of Music

by

Anthony Arthur Decuir
B.S., Xavier University, 1970
M.M.T., Loyola University, 1975
December 1981

ACKNOWLEDGEMENTS

The author wishes to express appreciation to Dr. Robert Shambaugh and the dissertation committee: Mr. Paul Abel, Dr. Milton Hallman, Dr. John Raush, and Dr. Wallace McKenzie. The author also is grateful to Mr. Charles Braswell and Dr. Keith Jacobs of Loyola University for their assistance in this project.

I also wish to express my love and appreciation to my wife, Sara, whose support was unflinching throughout the course of this project, and to Tony, Jr. and Patrice who displayed patience and understanding beyond their years.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	ii
ABSTRACT	x
Chapter	
I. INTRODUCTION	1
Topics to be Researched	2
Significance of the Topic	2
Delimitations	5
Method of Investigation	5
Development of the Course	6
Development of Remainder of Report	7
II. RELATED LITERATURE	8
Introduction	8
Historical Basis	8
A Review of Research in Music Therapy	19
Disorders of Childhood and Adolescents	20
Clinical Papers	21
Autism and Developmental Delay	22
Experimental Papers	23
Clinical Papers	24
Adult Mental Illness	25
Experimental Papers	25
Clinical Papers	27
General Disability	29
Physical Disability	30
Experimental Papers	31
Clinical Papers	32
Physical Disabilities: Cerebral Palsy	
and Communication Disorders	34
Cerebral Palsy	34
Clinical Papers	36
Communication Disorders	36
Clinical Papers	37

Geriatrics	38
Experimental Papers	38
Clinical Papers	40
Hearing Disorders, Disadvantaged, Penology and Substance Abuse	41
Hearing Disorders	41
Experimental Papers	41
Clinical Papers	42
Disadvantaged	43
Experimental Papers	43
Penology and Substance Abuse	44
Mental Retardation	46
Mental Retardation - Mild	47
Mental Retardation - Moderate	51
Clinical Papers	53
Mental Retardation - Severe and Profound	54
Summary	56
III. REVIEW AND COURSE UNITS	57
Review Unit 1	59
Experimental Design	59
Types of Research Designs	61
Three Good Experimental Designs	63
Research Terminology	64
Scales and Measurement	65
Assignment	66
Review Unit 2	68
Statistical Package for the Social Sciences, SPSS	71
Review Unit 3	75
t-Test	75
t-Test for Sample and Population Means	75
Methodology	75
t-Test for Two Independent Means	79
Methodology	80
t-Test for Related Measures	86
Methodology	87
Assignment	90
Review Unit 4	93
Simple One-Way Analysis of Variance	93
Example	93
Assignment	97
Unit 1-Analysis of Variance: Factorial Designs	100
Example	101

Unit 2-Analysis of Variance: Treatment	
Designs	109
Example	109
Unit 3-Analysis of Variance: Mixed	
Designs	118
Example	121
Unit 4-Analysis of Covariance	134
Unit 5-Multiple Correlation and	
Regression	145
Example	148
Multiple Regression	149
B Weights and Beta Weights	150
Probability Levels Associated with R	151
Cross Validation	152
Unit 6-Discriminant Function Analysis	153
Simple Discriminant Function Analysis	153
Multiple Discriminant Function	
Analysis	155
Example	156
Unit 7-Non-Parametric Statistics	165
The Tests	166
Chi square One-Sample Test (nominal)	167
Methodology	168
Example	169
The One-Sample Runs Test (ordinal)	172
Methodology	173
Kolmogorov-Smirnoff One-Sample	
Test (ordinal)	177
Methodology	177
Example	178
Summary	181
Unit 8-Chi square: Two Independent	
Samples	182
Example	186
Kolmogorov-Smirnoff Test for Two	
Independent Samples (ordinal)	188
Methodology	191
Example	192
Mann-Whitney U (ordinal)	193
Example	195
Summary	200
Unit 9-McNemar (nominal)	201
Methodology	202
Example	203
Wilcoxon Matched Pairs Sign Rank	
Test (ordinal)	206
Methodology	206

Example	210
Summary	210
Unit 10-Non-Parametric Statistics for	
More than Two Groups	212
Chi square (nominal)	212
Methodology	212
Example	217
Kruskal-Wallis One-Way Analysis of	
Variance (ordinal)	218
Methodology	220
Methodology	222
Summary	225
IV. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	227
Summary	227
Conclusions	229
Recommendations	230
.	
BIBLIOGRAPHY	231
VITA	251

LIST OF TABLES

1. Grading Policy	57
2. Review and Course Units	58
3. t-Test Data	76
4. Cent Difference in Pitch Reproduction	81
5. "Run" file entitled TTESTRUN; "data" file entitled TTESTDAT	84
6. T - T E S T	85
7. Scores on the Developmental Test of Visual-Motor Integration	88
8. "Run" file entitled CORRTRUN	91
9. "Data" file entitled CORRTDAT	91
10. Results of CORRDAT Analysis	92
11. Finger Temperature	94
12. Summary	97
13. "Run" file entitled UNIT1RUN	98
14. "Data" file entitled UNIT1DAT	99
15. Intensity	102
16. "Run" file entitled TREATRUN and the "data" file entitled TREATDAT	107
17. ANOVA Summary Table	108
18. "Run" file entitled LEVELRUN; data file entitled LEVELDAT	116

19. ANOVA Summary Table	117
20. Analysis of Variance	121
21.	
22. "Run" file entitled PRACTRUN	158
23. "Data" file entitled PRACTDAT	159
24. Group Means for Discrim Problem	160
25. Results	161
26. Discrim Anal On Practicum Data	162
27. Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)	163
28. Classification Results	164
29. "Run" file entitled FINGRRUN; "data" file entitled FINGRDAT	170
30. Results of FINGRDAT Analysis	171
31. Aural Acuity Scores	173
32.	
33. Results of the Runs Test	176
34. "Run" file entitled KOLGORUN	179
35. "Data" file entitled KOLGODAT	179
36. Kolmogorov-Smirnov Goodness-of-Fit Test	180
37. "Run" file entitled CHIS3RUN; "Data" file entitled CHIS3DAT	184
38. Chi square 2 by 2 Problem	185
39. "Run" file entitled KOLGO2DAT	189
40. "Data" file entitled KOLGO2DAT	189

41. Kolmogorov-Smirnov 2-Sample Test	190
42. "Run" file entitled MANNURUN	196
43. "Data" file entitled MANNUDAT	196
44. Mann-Whitney U Test	197
45. "Run" file entitled FREEFIELD	205
46. McNemar Test	205
47. "Run" file entitled WILCORUN	208
48. "Data" file entitled WILCORUN	208
49. Wilcoxon Matched-Pairs Signed-Ranks Test	209
50. "Run" file entitled CHIS2RUN	214
51. "Data" file entitled CHIS2DAT	215
52. Chi square 3 by 3 Problem	216
53.	
54. "Run" file entitled KRUSKRUN	221
55. "Data" file entitled KRUSKDAT	221
56. Kruskal-Wallis 1-Way ANOVA	222
57. Friedman Data	223
58. Friedman Two-Way ANOVA	224
59. "Data" file entitled FRIEDDAT; results of Friedman Analysis	224

ABSTRACT

The purpose of this study was to develop a course in experimental design and statistics for graduate music therapy students. This study was developed in order to address, specifically, research problems in music therapy. Two recent independent studies of graduate research projects of music therapy studies indicated that the chief deficiencies were inadequate research designs and the underutilization of statistical devices.

As an addendum to the development of the course, a survey of the statistical course offerings in graduate and undergraduate music therapy curricula was conducted. The sixty-four music therapy departments approved by the National Association for Music Therapy were surveyed. With a fifty-four percent response rate, the results indicated that seventy-one of the respondents generally felt that one semester of statistics adequately prepared the graduate and bachelor's level student to read and interpret research as well as to carry out their own research after graduation. These results were particularly interesting in light of the comments by the editor of the Journal of Music Therapy who mentioned that the primary reasons for the rejection of manuscripts are deficient experimental designs and inappropriate statistical usage.

The course contained a total of fourteen units: four review

units and ten course units. The topics covered in the review units were experimental research and terminology, introduction to the computer terminal, the t-test, and the completely randomized design. The ten course units covered various types of analyses of variance and covariance, multiple correlation and regression, discriminant function analysis, and non-parametric statistics. It is suggested the course continue to be restricted to graduate music therapy dents who have at least two semesters of statistics.

CHAPTER I

INTRODUCTION

The Loyola University Music Therapy Department was established in 1957. In 1967, a master's degree program was added to the existing undergraduate curriculum. The Loyola master's degree in music therapy requires a minimum of thirty credit hours and is primarily a research oriented degree. Students are required to achieve an adequate technical knowledge of statistics and research procedures while in the process of completing four research papers.

There are seven core courses in the graduate curriculum. Presently, graduate students are required to have completed three courses in experimental design and statistics. Most students entering the program usually have completed no formal courses in statistics or experimental design, while others may have had at least one course.

Loyola undergraduate students must complete two courses in statistics and experimental design to fulfill degree requirements. The courses are described as follows: Introduction to Research, which covers the nature of scientific investigation in general and particularly as it relates to the field of psychology; and Statistics and Methods, which focuses on descriptive and inferential statistical methods. The third and final course in the program, Experimental

Design, includes advanced experimental designs and methodologies, particularly as they relate to use of the computer terminal.¹ Currently these courses are taught outside of the Department.

Topic to be Researched

The primary purpose of this research was to develop an advanced statistics course which would address specific research problems in music therapy. That this course, with its specificity, is necessary can be seen in concurrent studies authored by members of the music therapy faculty.^{2,3} Both studies examined unpublished research papers of music therapy graduate students and found that the primary deficiencies were (1) inadequately conceived methodologies and (2) limited research designs. Other less frequently occurring deficiencies were (3) insufficiently explained research procedures and (4) inadequate descriptions of subjects.

Significance of the Topic

In the spring of 1980, a study was conducted as an addendum to

¹Explore the 80's at Loyola, Loyola University Bulletin, vol. LXVII, no. 1 (New Orleans: Loyola University Bulletin, 1980), pp. 298-299.

²Anthony A. Decuir, "Analysis of Fifteen Unpublished Research Reports in Music Therapy," New Orleans, 1979. (Mimeographed.)

³Cheryl D. Maranto, "An Analysis of Unpublished Research Reports in Music Therapy," New Orleans, 1979. (Mimeographed.)

the development of this course.⁴ The purpose of this study was to survey the statistical course offerings in graduate and undergraduate music therapy curricula. Faculty members of schools approved by the National Association for Music Therapy were sent questionnaires to determine the status of statistics courses in their respective departments. A fifty-four percent response rate was achieved from the sixty-four departments. The results indicated that seventy-one percent of the respondents did not require courses in statistics for undergraduate students. Those schools that did require statistics courses (either on an undergraduate or graduate level) required only one semester. Generally respondents felt that one semester of statistics adequately prepared the graduate and bachelor's level student to read and interpret research as well as to carry out their own research after graduation.

Thirty-eight of thirty-nine participants in the survey reported that statistical information was taught in courses other than statistics. While all of the respondents believed that it was important for students to be able to read and interpret research literature, the majority of respondents felt that a one-semester course was sufficient.

In a recent editorial appearing in the Journal of Music Therapy,

⁴Anthony A. Decuir, "A Survey of Statistical Course Offerings in Music Therapy," paper presented at the 31st Annual Conference of the National Association for Music Therapy, Minneapolis, Minnesota, 4 November 1980.

the official publication of the National Association for Music Therapy, Janet Perkins Gilbert⁵ listed deficient experimental designs and inappropriate statistical usage as reasons for the rejection of manuscripts. Gilbert⁶ also found that since 1972 more pure research has appeared in the Journal of Music Therapy than applied research. This fact seems to be explained in an article by Graham⁷, who stated that pure research is more of an academic exercise usually done to fulfill degree requirements. The author also reasoned that clinicians tend to be more prone toward practical problem-solving research, but are reluctant to subject their work to the scrutiny of an editorial board. With a decline in the total number of articles submitted to the Journal of Music Therapy (Jellison,⁸ Gilbert⁹), it appears that there is a tremendous need for research and statistical training specifically designed to meet the needs of music therapists.

⁵Janet Perkins Gilbert, "Guidelines to Contributors," Journal of Music Therapy 17 (Summer, 1980): 46-49.

⁶Janet Perkins Gilbert, "Published Research in Music Therapy, 1973-1978: Content, Focus, and Implications for Future Research," Journal of Music Therapy 16 (Fall, 1979): 102-110.

⁷Richard Graham, "Practical Research in Music Therapy," Journal of Music Therapy 6 (Winter, 1969): 94-97.

⁸Judith A. Jellison, "The Frequency and General Mode of Inquiry of Research in Music Therapy, 1952-1972," Council for Research in Music Education 35 (Winter, 1973): 1-8.

⁹Gilbert, "Published Research in Music Therapy, 1973-1978: . . ." 102-110.

Delimitations

The course to be developed will continue to be restricted to master's level music therapy students who have completed a minimum of two semesters of undergraduate statistics. While review units covering research terminology, experimental design, descriptive statistics, t-test, and analyses of variance will be included, these units are not intended to substitute for comprehensive study in these areas. An introduction to the computer terminal, while not a review unit, is listed with the review units because of the need to introduce the student to the terminal early in the semester.

Method of Investigation

A primary focus of the course was the utilization of pedagogical examples specific to music therapy. Unpublished and published research studies were cited to teach experimental design and rationale for the selection of statistical devices. The course was designed around the following behavioral objectives:

1. Given a set of data, students will select an appropriate statistical device and explain the rationale upon which the selection was based
2. Given a set of data, students will calculate statistics on a desk calculator or computer terminal, whichever is appropriate
3. Given the results of statistical tests, students will interpret the results using appropriate tabular, graphic or verbal presentations and describe to what extent the data may be generalized

Development of the Course

Concerning the selection of statistical devices to be presented in the course, music therapy professors were asked to select eighteen statistical devices that they felt were important for their students to know. Of the sixty-four professors surveyed, fifty-four percent responded. The devices chosen most often were chi square, t-test (both eleven percent), One-Way Analysis of Variance, Mann-Whitney U (both ten percent), Friedman Two-Way Analysis of Variance and the Wilcoxon Matched-Pairs Sign Rank Test (seven percent). The remaining tests received fewer choices.

Each unit contains an introduction which explains its rationale, and a detailed methodology which includes one or more examples for each statistic presented. At the end of each course unit there is a series of exercises and instructions for completing the exercises. The review and course units are as follows:

Review Units

- Unit 1. Research Terminology and Experimental Design - 1st Week and 2nd Week
- Unit 2. Introduction to the Computer Terminal - 3rd Week
- Unit 3. The t-test - 4th Week
- Unit 4. Simple One-Way Analysis of Variance: Completely Randomized Design - 5th Week

Course Units

- Unit 1. Analysis of Variance: Factorial Designs - 6th Week
- Unit 2. Analysis of Variance: Treatment Designs - 7th Week

- Unit 3. Analysis of Variance: Mixed Designs - 8th Week
- Unit 4. Analysis of Covariance -
- Unit 5. Multiple Correlation and Regression -
- Unit 6. Discriminant Function Analysis -
- Unit 7. Non-parametric Statistics: Test of Goodness-of-Fit -
- Unit 8. Non-parametric Statistics: Tests for Two Independent Samples -
- Unit 9. Non-parametric Statistics: Tests for Correlated Samples -
- Unit 10. Non-parametric Statistics: Tests for More than Two Groups -

Development of Remainder of Report

The remainder of the report is developed as follows:

Chapter II Related Literature

Chapter III Review and Course Units

Chapter IV Summary, Conclusions, and Recommendations

CHAPTER II

RELATED LITERATURE

Introduction

This review of the literature contains two sections, the first of which examines reports and minutes of the early research committees of the National Association for Music Therapy. These committee reports discuss the importance of research to the development of music therapy as a profession. The second section is a review of the literature to date in all of the disability areas in which music therapists work. The purpose for citing this literature is to illustrate to the student (1) the types of research currently being done in the profession and the skills required in order to contribute to this body of knowledge, and (2) finally, specific areas in which the literature is sparse.

Historical Basis

The National Association for Music Therapy (NAMT) was founded in 1950. From its very inception, research has occupied a primary place in NAMT. In the 1951 Yearbook, the objectives of the Association appear as follows:

1. To encourage and report research projects
2. To maintain a close working alliance with medical personnel

3. To maintain a close interest in the actual application of music in treatment programs in either a hospital or non-hospital setting
4. To offer assistance in maintaining and developing standards of training for hospital musicians and music therapists
5. To offer aid in the establishment of music therapy positions where budget and personnel allocations permit
6. To aid in the distribution of helpful information pertaining to music therapy¹⁰

Further evidence of this commitment can be seen in the research committee's publication of its "Aims and Definitions of Function." They are:¹¹

1. To identify and state critical hypotheses in need of being tested and explored
2. To clarify and help define basic concepts in music therapy
3. To aid the Executive Committee in publicizing information on experiments, findings, conclusions, and research projects for further verification and replication
4. To serve as a clearing house to help avoid futile or ill-advised research pursuits, by suggesting improvements or changes in experimental design in the interest of more efficient investment of time and resources
5. To provide some model experimental designs that might be at once general and typically suitable for investigating by standard approaches several sample problems
6. To accumulate a "suggestion-barrel" out of which to recommend good, well-formulated problems that may fit into a larger scheme of music therapy, having in mind a broad twenty-year plan of study

¹⁰Music Therapy 1951, Book of Proceedings of the National Association for Music Therapy (Chicago, Ill.: 1950 p. v.).

¹¹Ibid., p. 179.

7. To enlist the cooperation of clinical centers, music schools, and graduate schools, such as have departments of psychology, music education, medical schools, etc., whose students or research personnel are capable of pursuing the study of crucial problems in this field
8. To develop an evaluated listing of a music therapy bibliography which may be made available to persons needing such materials
9. To aid in the liason between the National Association for Music Therapy and the various psychiatric and medical associations

The driving belief of the founders of NAMT was that in order to build a profession a "solid body of information"¹² needed to be accumulated. The hallmark of this research, as expressed by the committee, was that it had to be "observable, measurable, predictable, and controllable."¹³ Such were the statements and beliefs promulgated in the formative years of NAMT to guide in the development of a research base.

Historically, writers in the music therapy profession adopted an attitude early in its existence of the importance of researchers selecting minute research problems. Anderson¹⁴ suggested that researchers concentrate on problems encountered by music therapists in clinical practice. He further suggested that in these initial stages

¹²Ibid.

¹³Ibid., p. 180.

¹⁴K. E. Anderson, "General Considerations: A Frame of Reference for Research," in Music Therapy 1952, ed. Esther Gilliland (Lawrence, Kansas: National Association for Music Therapy, 1953), p. 215.

in the development of the profession, stringent controls be exercised in seeking answers to rather small and limited research questions.

Anderson reasoned that

this atomistic approach to truth is perhaps necessary until such time as we have acquired a sort of 'psychological ownership' with regard to what we know in a particular field. In fact, I believe it hardly possible to proceed with an intelligent course of action based on research findings, until the workers in a field have psychological ownership with regard to knowledge and techniques peculiar to their bailiwick.¹⁵

It is interesting to note here that while Anderson refers to this frame of reference as "psychological ownership," Kuhn¹⁶ and others refer to it as a paradigm. A paradigm is defined as an "unusually recognized scientific achievement that for a time provides model problems and solutions to a community of practitioners."¹⁷

Bachrach¹⁸ further defined a paradigm as "a scientific model that has two major characteristics. First it offers a system by which events in the field can be explained better than they can be in existing models. Second it is sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve." Whether this pursuit of scientific validation is performed under the guise of "psychological ownership" or within the

¹⁵Ibid., p. 216.

¹⁶T. S. Kuhn, The Structure of Scientific Revolution, (Chicago: University of Chicago Press, 1962), p. 23.

¹⁷Ibid.

¹⁸A. J. Bachrach, Psychological Research, 3rd ed. (New York: Random House, 1972), p. 66.

framework of a "paradigm," the early writers in the field of music therapy stressed the importance of controls. Pepinsky¹⁹ stressed that scientific standing of the profession "ultimately depends on its method of research." And like other professions, astronomy and physics for example, researchers in music therapy will need to borrow from other professions, namely psychology, for experimental methods. Pepinsky further maintained that a carefully designed study will anticipate the procedures and statistical devices to be used in its evaluation.

Arthur Flager Fultz, who served as the chairman of the research committee for the National Association for Music Therapy from 1952 to 1953, discussed the importance of an accumulated body of literature to the specific science it represents. Fultz²⁰ outlined the relationship between literature and scientific validation around three points:

(1) the relation of a literature to its science, (2) the relation of broader fields of science, of more general scientific, but related disciplines seen in their literary background, to our own new, unexplored, comparatively untested field of knowledge in music therapy, and (3) the relation of our present backlog of research literature to our needs as therapists.

This author wrote that the importance of the literature of a science, besides giving the informed researcher an opportunity to add his

¹⁹A. Pepinsky, "Application and Mis-Application of Research Techniques in Music Therapy," in Music Therapy 1952, ed. Esther G. Gilliland (Lawrence, Kansas: National Association for Music Therapy, 1953), p. 224.

²⁰A. F. Fultz, "Research Literature," in Music Therapy 1952, ed. Esther G. Gilliland (Lawrence, Kansas: National Association for Music Therapy, 1954), p. 221.

thoughts, "eliminates the expensive waste of foolish reduplication and spurious floundering."²¹ It was further stressed that the membership not only needed to be aware of this stockpile of literature, but knowledgeable of its usefulness.

Fultz,²² in a paper entitled "The NAMT Long Range Design for Music Therapy Research" published in 1953, listed four broad areas in which music therapy interests should be distributed. The first area was "Existence of Music Therapy" which asked questions relevant to the existence of "such a process," and research and statistical methods employed in its validation. The second, "Nature of Music Therapy," dealt with experimentation and the classification of clinical observations. The third category, "Aims of Music Therapy," were related to diagnostic, prognostic, therapeutic, and prophylactic goals of therapy. The fourth and final area, "Use of Music Therapy," included all of the research questions centered around the actual clinical performance of music therapy.

Michel²³ further defined Fultz's categories by completing an actual count of the research papers found in each category. Reported

²¹Ibid.

²²A. F. Fultz, "The NAMT Long Range Design for Music Therapy Research," in Music Therapy 1953, ed. Mariana Bing (Lawrence, Kansas: National Association for Music Therapy, 1954), p. 221.

²³D. E. Michel, "Contemporary Research Projects in Progress Within the Long Range Design Framework - A Review of Trends," in Music Therapy 1953, ed. Mariana Bing (Lawrence, Kansas: National Association for Music Therapy, 1954), p. 229.

in Music Therapy 1953, he found few studies dealing with the process or an explanation of what is music therapy. Studies that were found were of a speculative nature and dealt primarily with clinical observation. Fultz²⁴ mentioned that the chief shortcoming of this research technique in music therapy was that because of the newness of the field observers were often naive and inexperienced at the techniques dealing with observational methods.

From the second category, "Nature of Music Therapy," Fultz reported several studies concerning music as a form of non-verbal communication and the effects of music on behavior. The third category, "Aims of Music Therapy - Diagnostic, Prognostic, Therapeutic and Prophylactic," produced only three references. In the fourth and final category, Michel found no references. Gaston²⁵ also listed by years the classroom research projects and master's theses completed by music students concerning the influence of music on behavior. Seventy-two papers are cited encompassing the years 1945 to 1954. It is interesting to note the importance of the graduate student and student research to the development of a research base in music therapy.

Other writers also expressed concern over the development of a research base in music therapy. Similar to Fultz and Michel,

²⁴Fultz, "Research Literature," p. 229.

²⁵E. T. Gaston, "The Development of a Research Program," in Music Therapy 1954, ed. E. T. Gaston (Lawrence, Kansas: National Association for Music Therapy, 1955), p. 239-42.

Pepinsky²⁶ wrote that music therapy was "at a crossroads," leaving behind the many false claims of how music controlled the mind, and adopting, with some degree of caution, "true research in psychiatry."²⁷ He described the crossroads in terms of researchers pursuing basic research questions, or evolving better theoretical considerations of stimulus-response.²⁸ His answer to his question was that both alternatives must be judiciously pursued.

Pepinsky referred to the need of true research both in music therapy and psychiatry. In a later article, he again described the state of research in music therapy as still largely observational and speculative.²⁹ This fact he reasoned was due to a lack of training in research methods. Further, this author reported that advice sought by contributors from the research committee dealt with questions concerning statistical analysis.³⁰ Pepinsky believed that such inquiries were at best "putting the horse before the carriage" because these inquiries should have been concerned with experimental design, and asked prior to the collection of the data.³¹

²⁶A. Pepinsky, "Introductory Remarks," in Music Therapy 1954, ed. E. T. Gaston (Lawrence, Kansas: National Association for Music Therapy, 1955), p. 236.

²⁷Ibid.

²⁸Ibid.

²⁹Pepinsky, "Introductory Remarks," p. 235.

³⁰A. Pepinsky, "Research Session Introductory Remarks," in Music Therapy 1955, ed. E. T. Gaston (Lawrence, Kansas: National Association for Music Therapy, 1956), p. 207.

³¹Ibid., p. 208.

Perhaps Gaston best summarized the nature of the difficulties faced by researchers in this new field. He wrote that music therapists had to learn methods for qualifying and describing data in order to survive in a technological world.³² However, much of the difficulty facing music therapists was due to the arduous task of combining art and science in a controlled research situation. And, like earlier writers, Gaston believed that this quest for scientific verification "must begin humbly with classification and verification of small bits of knowledge rather than in a grandiose fashion." He cautioned that "however may be considered the relationship and balance of art and science, once the music therapist has undertaken research, he has committed himself to scientific procedures, because research is the essential feature of science."³³ Thus, these early comments summarized the views held by E. Thayer Gaston who is considered now to be the "father of music therapy."

In the second decade of the Association, researchers continued their interest in the "effects and affects of music on the individual."³⁴ Most of these topics, researched by graduate students of the University of Kansas, concerned the "intra" effects of music. More

³²E. T. Gaston, "Introductory Remarks, 'Research and Music Therapy'," in Music Therapy 1956, ed. E. T. Gaston (Lawrence, Kansas: National Association for Music Therapy, 1957), p. 228.

³³Ibid.

³⁴C. E. Braswell, "The Future of Psychiatric Music Therapy," in Music Therapy 1961, ed. Erwin Schneider (Lawrence, Kansas: National Association for Music Therapy, 1962), p. 74.

specifically, these effects dealt with behavioral responses due to stimulative and sedative music, pictorial projective responses to music, and human postural responses induced by musical stimuli.³⁵ Braswell reported that these research topics, while important to the early development of the profession, became less dramatic with the advent of psychotropic drugs which produced behavioral responses much quicker than music.³⁶ A more pregnant avenue of research, reasoned Braswell, would be sociological effects of music - namely the effects due to group interaction. This sociological view of research in music therapy was advocated because this author felt that the experimental research models of psychology were outside of the training of the music therapist.³⁷

This curriculum emphasis on education and research advocated by Braswell was continued in later reports with the point of departure being training standards developed by the Education Committee of NAMT in 1952. These standards covered three general areas: (1) specific skill development, (2) knowledge of history and theory of the influence of music on behavior, and (3) clinical experiences during the matriculation period and research expertise in the field.³⁸ Concerning

³⁵Ibid.

³⁶Ibid., p. 75.

³⁷Ibid., p. 76.

³⁸ Charles E. Braswell, "Education and Research in Music Therapy," in Music Therapy 1960, ed. Erwin H. Schneider (Lawrence, Kansas: National Association for Music Therapy, 1961), p. 35.

research, Braswell wrote that research inquiry should be directed both in applied and theoretical areas. The difficulty that the educator encounters, however, is when during the undergraduate training experience are the research skills to be established. With most of the curriculum already filled with various courses in music, psychology, and sociology, comprehensive training in experimental research is nearly impossible. However, courses dealing with the basic procedural components of research could be taught. These basic skills include problem and purpose statements, experimental designs and quantitative methods.³⁹ Similar to statements of earlier researchers, this writer also advocated the completion of small projects which require only limited procedures and data evaluation methods.

Before closing a colorful chapter in the history of music therapy as reported in the research papers appearing in the music therapy yearbooks, it should be noted that experimental and descriptive research models were the primary types of research pursued during the first decade of the Association. In the final two issues of the yearbooks, two historical reports appeared which were authored by Ruth Boxberger. The first was entitled "Historical Bases for the Use of Music in Therapy" and was an anthropological approach to the use of music in therapy.⁴⁰ The author discussed medical implications of music

³⁹ Ibid., p. 38.

⁴⁰ Ruth Boxberger, "Historical Bases for the Use of Music in Therapy," in Music Therapy 1961, ed. Erwin H. Schneider (Lawrence, Kansas: National Association for Music Therapy, 1962), p. 125.

and the musician in the release of emotions in the cathartic experience. Other topics on this subject included Greek philosophy, music's role in Greek society, medieval music and medicine, and the therapeutic use of music in the Baroque and Renaissance periods.

The second publication by this author was the history of NAMT.⁴¹ Boxberger began the history from its inception and its early connections with the National Therapeutic Society of New York City founded in 1903, the National Association for Music in Hospitals, and the National Foundation for Music Therapy established in 1941.⁴² Another extremely informative section of this project was entitled "The Period of Formation." Included here were events leading to the "formation of the National Association for Music Therapy" and actual minutes of the various standing committees of the new Association.⁴³

The 1962 Yearbook was the last in which all of the business of the Association was published under this format. Beginning in 1963, the Journal of Music Therapy became the official research organ of NAMT.

A Review of Research in Music Therapy

This review of the literature related to the use of music therapy

⁴¹Ruth Boxberger, "History of the National Association for Music Therapy, Inc.," in Music Therapy 1962, ed. Erwin H. Schneider (Lawrence, Kansas: National Association for Music Therapy, 1963), p. 133.

⁴²*Ibid.*, p. 140.

⁴³*Ibid.*, p. 151.

will cover research in the following disability areas: physical disability, gerontology, drug abuse, penology, adult and childhood mental illness, and mental retardation.

Disorders of Childhood and Adolescents

In the recent history of music therapy, many studies have appeared in the literature supporting the contingent use of music. The behavioral approach has been successful in dealing with emotionally disturbed children. These studies described the successful application of contingent music to improve arithmetic scores (Miller, Dorow and Green),⁴⁴ and inappropriate and disruptive classroom behaviors, such as fighting and getting-out-of-seat (McCarty, McElfresh, Rice and Wilson,⁴⁵ Manser,⁴⁶ Wilson⁴⁷). Still another technique found to be useful with emotionally disturbed children was Crocker's music projective technique which appeared in the literature in 1955.⁴⁸ A

⁴⁴D. M. Miller et al., "The Contingent Use of Music and Art for Improving Arithmetic Scores," Journal of Music Therapy 11 (Summer, 1974): 57-64.

⁴⁵B. C. McCarty et al., "The Effects of Contingent Background Music on Inappropriate Bus Behavior," Journal of Music Therapy 15 (Fall, 1978): 50-56.

⁴⁶S. B. Hanser, "Group-Contingent Music Listening with Emotionally Disturbed Boys," Journal of Music Therapy 11 (Winter, 1974): 220-225.

⁴⁷C. V. Wilson, "The Use of Rock Music as a Reward in Behavior Therapy with Children," Journal of Music Therapy 13 (Spring, 1976): 40-47.

⁴⁸Dorothy B. Crocker, "Music as a Projective Technique," in Music Therapy 1955, ed. E. Thayer Gaston (Lawrence, Kansas: National Association for Music Therapy, 1956), pp. 86-97.

replication of this technique under experimental conditions was accomplished by Grossman.⁴⁹ The results indicated that children told stories to music which were not only autobiographical, but were effected by different types of music.

Clinical Papers

Numerous papers have appeared in the literature concerning the use of music in the treatment of childhood and adolescent disorders. Projective techniques with these clients have been combined successfully with music, as already mentioned by Crocker⁵⁰ and together with music and art by Diephouse,⁵¹ Mitchell,⁵² Crockford,⁵³ and Sheppard.⁵⁴

The potency of music from a sociological viewpoint was described by Braswell in the Music Therapy Yearbooks. Several writers in recent years have pursued the social aspects of music in terms of small

⁴⁹S. Grossman, "An Investigation of Crocker's Music Projective Techniques for Emotionally Disturbed Children," Journal of Music Therapy 15 (Winter, 1978): 179-184.

⁵⁰Crocker, "Music as a Projective Technique," p. 86-97.

⁵¹D. A. Diephouse, "The Evolution of a Music Therapy Program for Children," Psychiatric Quarterly Supplement 38 (1964): 119-126.

⁵²C. G. Mitchell, "Bedtime Music for Psychotic Children," Nursing Mirror 122 (1966): 452.

⁵³C. Crockford, "Making the Most of Rhythm and Song: An Invitation to the Withdrawn Child," Journal, Canadian Association for Music Therapy 5 (Summer, 1977): 7-8.

⁵⁴T. Sheppard, "Relationship Therapy Through Music with Maladjusted Boys," British Journal of Music Therapy 8 (Summer, 1977): 6-10.

group dynamics. Lehrer-Carle⁵⁵ used a four-stage approach with regressed, noninvolved schizophrenic patients. The stages involved activities in sound awareness, body percussion, and group conversation. Another group technique used involved first teaching the clients to read a percussion score and later producing background sounds to illustrate stories as well as telling stories to accompany background sounds (Powell⁵⁶), while more traditionally, Ragland and Apprey⁵⁷ successfully used a singing group activity with underprivileged adolescents.

Autism and Developmental Delay

Early infantile autism is a disorder which manifests itself in the early stages of childhood. The child exhibits an unwillingness to socialize, to relate to his environment, or maintains only peripheral human contact. Developmental delay is a childhood disability which manifests itself as a delay in the normal functioning of the child, such as, communication and socialization skills or perceptual-motor skills.

⁵⁵I. Lehrer-Carle, "Group Dynamics as Applied to the Use of Music with Schizophrenic Adolescents," British Journal of Music Therapy 4 (Summer, 1973): 10.

⁵⁶L. Powell, "Music with Emotionally Handicapped Teenagers," Proceedings, Fourth National Conference, Australian Music Therapy Association, 1978, p. 41.

⁵⁷Z. Ragland and M. Apprey, "Community Music Therapy with Adolescents," Journal of Music Therapy 11 (Fall, 1974): 47-55.

Experimental Papers

Stevens and Clark⁵⁸ reported success in reducing antisocial behaviors of five autistic boys using activities involving singing and action songs. Also with autistic clients soul music was used contingently to increase appropriate social behaviors such as walking and car riding by Reid, Hill, Rowers, and Montegar.⁵⁹

Developmental delay is defined as a retardation of the normal developmental pattern of children. While these children are not retarded in the normal sense of the word, due to a variety of disorders i.e., autism, borderline retardation, psychosis, minimal brain dysfunction or adjustment behavior, they function "at least one level below their grade norm."⁶⁰ Cartwright and Huckaby⁶¹ used a comprehensive program composed of music, social games, physical exercise, and educational aids to increase scores on the Verbal Language Development Scale and the Peabody Picture Vocabulary Test. In an experimental and control group study using speech delayed children,

⁵⁸E. Stevens and F. Clark, "Music Therapy in the Treatment of Autistic Children," Journal of Music Therapy 6 (Winter, 1969): 98-104.

⁵⁹D. H. Reid et al., "The Use of Contingent Music in Teaching Social Skills to a Nonverbal Hyperactive Boy," Journal of Music Therapy 12 (Spring, 1975): 2-17.

⁶⁰J. Cartwright and G. Huckaby, "Intensive Preschool Language Program," Journal of Music Therapy 9 (Fall, 1972): 137-146.

⁶¹Ibid.

Seybold⁶² found that an experimental group receiving a combination music and speech therapy program showed more gains on the Houston Test for Language Development than a control group which received only a speech therapy program designed specifically for speech delayed clients.

Clinical Papers

Clinical approaches used for the treatment of the autistic are varied. While authors in the field recognize the general needs of the autistic child as development of socialization and interpersonal communication skills, reality contact, increasing verbalization and eye contact, diverse approaches are used to achieve these goals. Generally, clinicians have used movement activities singularly or combined with rhythm, Orff-Schulwerk, singing, and activities which used sounds familiar to the child (Frankel,⁶³ Ludwig and Tyson⁶⁴ O'Connell,⁶⁵ Goldstein,⁶⁶ Mahlberg⁶⁷).

⁶²C. D. Seybold, "The Value and Use of Music Activities in the Treatment of Speech Delayed Children," Journal of Music Therapy 8 (Fall, 1971): 102-110.

⁶³N. B. Frankel, "The Autistic Psychotic Child: The Use of Music Therapy," Bulletin, Children's Hospital 2 (January, 1977): 14-16.

⁶⁴A. J. Ludwig and F. Tyson, "A Song for Michael," Journal of Music Therapy 6 (Fall, 1969): 82-86.

⁶⁵T. S. O'Connell, "The Musical Life of an Autistic Boy," Journal of Autism and Childhood Schizophrenia 4 (Winter, 1974): 223-229.

⁶⁶C. Goldstein, "Music and Creative Arts Therapy for an Autistic Child," Journal of Music Therapy 1 (Winter, 1964): 135-138.

⁶⁷M. Mahlberg, "Music Therapy in the Treatment of an Autistic Child," Journal of Music Therapy 10 (Winter, 1973): 189-193.

Adult Mental Illness

Perhaps the treatment category in which music therapy had its initial impact was in treatment situations dealing with adults. Characteristically, the literature in this area contains numerous citations. However, many therapists list adult psychiatric patients as among the most difficult to work with.

Experimental Papers

In a study using the Draw-A-Person test to evaluate body concept and cognition, McCarty⁶⁸ used a dance therapy program to achieve significant results with eight adult psychiatric patients. Relatedly, rhythmic exercises were used successfully to reduce the pulse rate of twenty-three schizophrenic patients (Shatin⁶⁹).

Various physiological responses of adult psychiatric patients also have been recorded. Heckel, Wiggins, and Salzburg⁷⁰ studied the effects of tempo of background music on the rate of speech in group psychotherapy. Music which had a fast tempo (172 MM) yielded significantly more words per minute than music of a slow tempo (60 MM).

⁶⁸H. McCarty, "Use of the Draw-A-Person Test to Evaluate a Dance Therapy Program," Journal of Music Therapy 10 (Fall, 1973): 144-155.

⁶⁹Leo Shatin, "The Application of Rhythmic Music Stimuli to Long-Term Schizophrenic Patients," in Music Therapy 1957, ed. E. Thayer Gaston (Lawrence, Kansas: National Association for Music Therapy, 1958), p. 169-178.

⁷⁰R. V. Heckel et al., "The Effects of Musical Tempo in Varying Operant Speech Levels in Group Therapy," Journal of Clinical Psychology 19 (January, 1963): 129.

Slaughter⁷¹ studied the effects of stimulative and sedative music on pupillary responses of ten psychotic patients. The results revealed that the pupils of the subjects were larger with stimulative music than with sedative music. These clients also reported that they associated physical activity with stimulative music and rest or relaxation with sedative music.⁷² Loudness preference of these clients was the topic of a study by Bonny.⁷³ Twenty-four patients were randomly selected from the patient population of a midwestern Veterans Administration hospital. An equal number of hospital employees served as control subjects. The results indicated that patients preferred loudness levels which were significantly softer than those preferred by employees. It was also revealed that patients attempted to alter the volume of the music less frequently than did employees.

Hauck and Martin used music on a contingent basis to control the duration of time-out. Time-out is a technique used in behavior management whereby a student is temporarily excluded from activities as a form of punishment. The authors found that the music used contingently was effective in reducing the incidence of stereotypic

⁷¹F. E. Slaughter, "Effects of Musical Stimuli on Normal and Abnormal Subjects as Indicated by Pupillary Reflexes," in Music Therapy 1953, ed. Mariana Bing (Lawrence, Kansas: National Association for Music Therapy, 1954), p. 246.

⁷²Ibid.

⁷³H. L. Bonny, "Preferred Loudness of Recorded Music of Hospitalized Psychiatric Patients and Hospital Employees," Journal of Music Therapy 5 (Spring, 1968): 44-52.

behaviors such as body rocking.⁷⁴ Background music was used by Sommer⁷⁵ in a group psychotherapy model to "support the theory that suitable background music is a means of increasing verbal interaction in group psychotherapy."

The sociological implications of music group participation were studied by Cassity. In a study which explored group cohesion and peer acceptance, fourteen subjects were divided into experimental and control groups. The experimental subjects received group guitar lessons leading to a performance while the control group engaged in normal hospital activities. Using a technique called sociometry where individual group members are asked to rank other group members according to whom they preferred associating with, experimental group members made more in-group selections than their control group counterparts.⁷⁶

Clinical Papers

The clinical approaches cited in the literature range from single activities to entire activity therapy programs. Wasserman⁷⁷

⁷⁴L. P. Hauck and P. L. Martin, "Music as a Reinforcer in Patient-Controlled Duration of Time-Out," Journal of Music Therapy 7 (Summer, 1970): 43-53.

⁷⁵D. L. Sommer, "Music Therapy Without Music," Bulletin of the National Association for Music Therapy 10 (May, 1961): 4-12.

⁷⁶M. D. Cassity, "The Influence of a Music Therapy Activity Upon Peer Acceptance, Group Cohesiveness, and Interpersonal Relationships of Adult Psychiatric Patients," Journal of Music Therapy 13 (Summer, 1976): 66-75.

⁷⁷N. M. Wasserman, "Music Therapy for the Emotionally Disturbed in a Private Hospital," Journal of Music Therapy 9 (Summer, 1972): 99-104.

utilized guitar, piano, and voice lessons in a program which was designed to initiate patients to musical activities as well as to encourage their participation when released from the hospital. Singing, rhythm band, and musical games were used by Pendergrass.⁷⁸ Goward used activities composed of singing, movement to music, and instrumental performance.⁷⁹ Singing alone was used by Ficken,⁸⁰ Wells,⁸¹ and Taylor.⁸²

Movement and dance activities were employed by Wadeson,⁸³ and Carroccio and Quattlebaum.⁸⁴ While usually reserved for children or adolescents, handbell choirs were used with adult psychiatric patients

⁷⁸P. E. Pendergrass, "Therapy Through Service to Others," Journal of Music Therapy 2 (Fall, 1965): 86-89.

⁷⁹B. Goward, "Stimulating Regressed Patients," British Journal of Music Therapy 5 (Fall, 1974): 22-26.

⁸⁰T. Ficken, "The Use of Songwriting in a Psychiatric Setting," Journal of Music Therapy 14 (Winter, 1976): 163-172.

⁸¹A. Wells, "Values and Problems of Patient Performances," in Music Therapy 1957, ed. E. Thayer Gaston (Lawrence, Kansas: National Association for Music Therapy, 1958), p. 56-64.

⁸²D. Taylor, "Expressive Emphasis in the Treatment of Intropunitive Behavior," Journal of Music Therapy 6 (Summer, 1969): 41-43.

⁸³H. Wadeson, "Combining Expressive Therapies," American Journal of Art Therapy 15 (1976): 43-46.

⁸⁴D. F. Carroccio and L. F. Quattlebaum, "An Elementary Technique for Manipulation of Participation in Ward Dances at a Neuropsychiatric Hospital," Journal of Music Therapy 6 (Winter, 1969): 108-109.

by Rubin⁸⁵ and Bruner-Orne.⁸⁶

Less traditional activities were employed by Brown and Seliger. These authors employed single note flutes in a forced participation model with severely regressed, institutionalized schizophrenic patients.⁸⁷ Wilke⁸⁸ established a radio program whereby patients took turns being the disc jockey, selecting music to be played and studio activities. Reacculturation of patients through the use of environmental sounds was employed by Sommer.⁸⁹

General Disability

This section is entitled "general" because it contains a mixture of several disability areas which are different from those already presented. The references in this section deal with physical disabilities, geriatrics, and a heterogeneous grouping of citations on

⁸⁵B. Rubin, "Handbells in Therapy," Journal of Music Therapy 13 (Spring, 1976): 49-52.

⁸⁶M. Bruner-Orne, "The Use of Handbells in Music Therapy in a Hospital Setting," in Music Therapy 1955, ed. E. Thayer Gaston (Lawrence, Kansas: National Association for Music Therapy, 1956), p. 219-223.

⁸⁷M. E. Brown and M. Seliger, "A Nontherapeutic Device for Approaching Therapy in an Institutional Setting," Journal of Group Psychotherapy 19 (January, 1969): 88-95.

⁸⁸M. Wilke, "The Disc Jockey Jamboree," in Music Therapy 1960, ed. Erwin H. Schneider (Lawrence, Kansas: National Association for Music Therapy, 1961), p. 47-53.

⁸⁹D. T. Sommer, "Music Therapy Without Music," Bulletin of the National Association for Music Therapy 10 (Summer, 1961): 3.

hearing disorders, disadvantaged, penology, and substance abuse. In the brief history of music therapy, the areas contained in this section have received little attention by researchers. Much of the fault for this neglect is perhaps attributable to the fact that these clients are not hospitalized in large psychiatric institutions, state schools, or areas where music therapists traditionally are employed.

Physical Disability

According to Nebe, "disability" in vocational rehabilitation include mental disorders, emotional disturbance, and physical handicaps. However, in 1968 disadvantaged individuals were included. Currently, disability includes individuals who are unemployed due to physical or mental disability, low educational performance, or delinquency and prison background. Rehabilitation services provided for the client are "1. medical examinations; 2. surgery, treatment, and convalescent services; 3. prosthetic and orthotic appliances; 4. vocational evaluation and work adjustment; 5. vocational and educational training; 6. supplies, transportation, and maintenance; 7. tools, equipment, and licenses; 8. job placement; 9. job follow-up."⁹⁰ Music therapy functions mainly in this setting to enhance the social and interactional skills of the client in an attempt to foster self-sufficiency within the client.⁹¹

⁹⁰H. J. Nebe, "Music Therapy - Its Function in Supporting the Rehabilitation of the Handicapped," Journal of Music Therapy 8 (Spring, 1971): 3-11.

⁹¹Ibid.

Experimental Papers

Braswell, Buttram, Goldstein, Ott, and Schoenberger⁹² investigated the use of music therapy in a vocational rehabilitation setting. These authors studied the effects of music therapy activities on self-concept, social skills, and rehabilitation potential in an experimental-control group design. While significant differences were not found in interpersonal relationships or self-concept, significant differences were observed between the groups for rehabilitation potential in favor of the experimental group.⁹³ A follow-up study by Schoenberger⁹⁴ examined social, educational, and vocational success of experimental and control group clients after termination from the center. From a questionnaire sent to both experimental and control group clients and their employers, the results indicated that members of the experimental group experienced greater success in securing employment or additional education, and attaining social satisfaction in employment, educational, or social situations.

Relatedly, Wolfe⁹⁵ examined the use of music, occupational and recreational therapy to increase activity levels and positive verbalization among individuals experiencing chronic pain from a variety of

⁹²C. Braswell et al., "The Influence of Music Therapy on Vocational Potential," Journal of Music Therapy 7 (Spring, 1970): 28-38.

⁹³Ibid.

⁹⁴Leonard Schoenberger, "Music Therapy and Vocational Achievement," Journal of Music Therapy 8 (Spring, 1971): 12-25.

⁹⁵D. E. Wolfe, "Pain Rehabilitation and Music Therapy," Journal of Music Therapy 15 (Winter, 1978): 162-178.

causes. The results revealed that "music may well function as an effective diversional tool to aid in inhibiting the perception of chronic pain."⁹⁶ Pendleton et al.,⁹⁷ found the use of the metronome to be beneficial in aiding insomnia patients, especially when used with muscle relaxation.

Clinical Papers

The clinical approaches used in the rehabilitation of the physically disabled are as varied as the disorders themselves. Client populations to be discussed will include burn patients, handicapped children, physically disabled, dystrophic, and the blind.

Christenberry⁹⁸ used singing, handclapping, and guitar activities to aid in the rehabilitation of burn patients. Sr. Josepha found piano lessons well suited for the treatment of a patient with Erb-Duchenne paralysis, a disorder which effects the left shoulder, arm, and hand.⁹⁹ In the rehabilitation of handicapped and nonhandicapped

⁹⁶Ibid.

⁹⁷L. R. Pendleton et al., "Effects of Metronome - Conditioned Relaxation, Metronome - Induced Relaxation, and Progressive Muscle Relaxation on Insomnia," Behavior Research and Therapy 14 (1976): 165-166.

⁹⁸E. B. Christenberry, "The Use of Music Therapy with Burn Patients," Journal of Music Therapy 16 (Fall, 1979): 138-48.

⁹⁹Sr. M. Josepha, "Therapeutic Value of Instrumental Performance for Severely Handicapped Children," Journal of Music Therapy 1 (Fall, 1964): 74-79.

children, Band¹⁰⁰ used singing in conjunction with an activity which centered on the identification of environmental sounds. A comprehensive dance therapy program was employed by Hecox, Levine, and Scott¹⁰¹ for use with physically disabled patients. With muscular dystrophic children, Korson¹⁰² employed musical stories accompanied by piano or glockenspiels, recorders, drums, and autoharps. This author believed that these activities along with puppetry helped the client to become more self-sufficient.

A variety of different types of activities were found to be useful with blind clients. Capek¹⁰³ used voice and piano to work toward the goals of interaction, manipulation, involvement, general instrument and rhythmic knowledge, learning, and relaxation. Additionally, the author believed that clients should be exposed to as many musical sounds and experiences as possible. Similarly, Brunton¹⁰⁴ involved blind children in a wide range of musical activities such as singing, recorder playing.

¹⁰⁰E. Band, "Working with the Power of the Sound Experience in Early Development and Therapy," Journal, Canadian Association for Music Therapy 6 (1978): 15-20.

¹⁰¹B. Hecox et al., "Dance in Physical Rehabilitation," Physical Therapy 58 (August, 1976): 919-924.

¹⁰²Francis Korson, "Music Therapy for Children with Muscular Dystrophy," in Music Therapy 1957, ed. E. Thayer Gaston (Lawrence, Kansas: National Association for Music Therapy, 1958), p. 192-198.

¹⁰³A. Capek, "Music and the Blind Child," Proceedings of the Second National Conference of the Australian Music Therapy Association, 1976, p. 6.

¹⁰⁴K. M. Brunton, "Music with Blind Children," Conference Papers British Society for Music Therapy, 1962-67, p. 1.

handbells, rhythm band, piano instruction, movement of music, music appreciation, and record listening.

Physical Disabilities: Cerebral Palsy
and Communication Disorders

This second section of literature on physical disabilities contains the experimental and clinical literature on the use of music therapy in cerebral palsy and communication disorders. Cerebral palsy is a disorder which effects the motor ability of an individual and is caused by lesions in the brain occurring most often at birth. The motor impairment is most often manifested by "lack of control of arms, legs, tongue, speech mechanisms, eyes, or hearing."¹⁰⁵ Also, there is a close relationship between cerebral palsy and the incidence of mental retardation.

Cerebral Palsy

Berel, Diller, and Orgel investigated the use of "music as a facilitator for visual motor sequencing tasks in children with cerebral palsy."¹⁰⁶ The authors studied the ability of cerebral palsy children to initiate tonal sequencing played on muffled or unmuffled instruments, and placed at various locations in reference to the listener.

¹⁰⁵H. Nordholm, "Music for the Cerebral Palsied Child," in Music Therapy 1953, ed. Mariana Bing (Lawrence, Kansas: National Association for Music Therapy, 1954), p. 91-99.

¹⁰⁶M. Berel et al., "Music as a Facilitator for Visual Motor Sequencing Tasks in Children with Cerebral Palsy," Developmental Medicine and Child Neurology 13 (1971): 335-342.

The results of the study indicated that the clients performed better on unmuffled instruments. Performance seemed to be related to IQ rather than the physical proximity of the instruments.

Ball, McCrady, and Hart used mercury switches connected to a portable radio on a contingent basis to increase the amount of time two cerebral palsied children held their heads erect.¹⁰⁷ Fingering, breath support, and coordination of blowing was studied by Herron. Using a melodica, the results indicated that muscular coordination and the use of fingers and hand improved for all of the clients.¹⁰⁸

The effects of background music on the ability of cerebral palsied children to perform certain tasks were studied by Schneider¹⁰⁹ and Ditson.¹¹⁰ The results of both studies revealed that background music or music "passively applied" did effect the performance abilities of cerebral palsy children.

¹⁰⁷T. S. Ball et al., "Automated Reinforcement of Head Posture in Two Cerebral Palsied Retarded Children," Perceptual and Motor Skills 40 (April, 1975): 619-622.

¹⁰⁸C. J. Herron, "Some Effects of Instrumental Music Training on Cerebral Palsied Children," Journal of Music Therapy 7 (Summer, 1970): 55-58.

¹⁰⁹E. H. Schneider, "Relationship Between Musical Experience and Certain Aspects of Cerebral Palsied Children's Performance on Selected Tasks," in Music Therapy 1956, ed. E. Thayer Gaston (Lawrence, Kansas: National Association for Music Therapy, 1957), p. 250-277.

¹¹⁰R. Ditson, "A Study of the Effects of Moderate Background Music on the Behavior of Cerebral Palsied Children," Bulletin of the National Association for Music Therapy 10 (September, 1961): 6.

Clinical Papers

Clinical approaches for cerebral palsy patients have been traditional. Bixler¹¹¹ used the production of an operetta with cerebral palsy children. The author felt that "desirable social, physical and artistic behaviors were fostered by these productions." While group singing and rhythmic activities were used by Holser and Krantz,¹¹² a total program of group singing, rhythm activities, listening to music, and playing musical instruments was utilized by Nordholm¹¹³ and Weigl.¹¹⁴

Communication Disorders

The literature presented on communication disorders is related to four general disability areas. Those areas are Broca's aphasia, stuttering, articulation disorders, and cleft palate disorders.

Twenty-four patients with Broca's aphasia were examined by Yamadori, Osumi, Masuhara, and Okubo.¹¹⁵ The results of this study

¹¹¹J. Bixler, "Operetta Production with Physically Handicapped Children," in Music Therapy 1960, ed. E. H. Schneider (Lawrence, Kansas: National Association for Music Therapy, 1961), p. 101-104.

¹¹²P. Holser and R. Krantz, "Music Therapy in an Adult Cerebral Palsy Center," American Journal of Occupational Therapy 14 (March, 1960): 61-63.

¹¹³Nordholm, "Music for the Cerebral Palsied Child," p. 91.

¹¹⁴V. Weigl, "Functional Music with Cerebral Palsied Children," in Music Therapy 1954, ed. E. Thayer Gaston (Lawrence, Kansas: National Association for Music Therapy, 1955), p. 135-143.

¹¹⁵A. Yamadori et al., "Preservation of Singing in Broca's Aphasia," Journal of Neurology, Neurosurgery, and Psychiatry 40 (March, 1977): 221-224.

appeared to indicate "that the right hemisphere is dominant over the left for singing capacity." Healey, Mallard, and Adams studied the effects of singing on stuttering of eight adult males. The results indicated that stuttering was reduced significantly when subjects sang familiar songs.¹¹⁶

Clinical Papers

Articulation disorders, namely dyspraxia, hyperrhinophonia, and general dyslalia were the subject of a paper by Ogden. The author found singing activities to be beneficial with these articulation problems.¹¹⁷ Sparks and Holland found the use of melodic intonation therapy (MIT) beneficial in the treatment of aphasic patients.¹¹⁸ Melodic intonation therapy is a technique similar to vocal recitative with a range of three or four notes. Michel¹¹⁹ employed a tape recorder, singing lessons, and a flutophone in the rehabilitation of patients with cleft palate disorders.

¹¹⁶E. C. Healey et al., "Factors Contributing to the Reduction of Stuttering During Singing," Journal of Speech and Hearing Disorders 19 (September, 1976): 475-480.

¹¹⁷J. Ogden, "Application of Music to the Treatment of Children Suffering Functional Disorders of Speech and Language," Proceedings, Second National Conference, Australian Music Therapy Association, (1976): 23-28.

¹¹⁸R. W. Sparks and A. L. Holland, "Method: Melodic Intonation Therapy for Aphasia," Journal of Speech and Hearing Disorders 41 (August, 1976): 287-297.

¹¹⁹D. E. Michel, "Music Therapy in Cleft Palate Disorders," in Music Therapy 1961, ed. E. H. Schneider (Lawrence, Kansas: National Association for Music Therapy, 1962), p. 111-115.

Galloway's¹²⁰ article, "Stuttering and the Myth of Therapeutic Singing," presented literature which refutes the belief that singing is beneficial therapy for stutterers. The author cited evidence that while fluency was exhibited during singing, other activities also produced this same fluency. He also wrote that while fluency was improved during singing and other activities, these periods of fluency were not carried over into normal speaking.

Geriatrics

One of the fastest growing disability areas in terms of funding and public support is gerontology. Braswell, Maranto, and Decuir¹²¹ reported in 1979 that four percent of the registered music therapists practicing in the United States worked in geriatrics. In comparison to the other disability areas, most of the literature related to geriatrics is somewhat recent--appearing within the last ten years.

Experimental Papers

The research literature covering the use of music with geriatric patients is centered around five general areas: musical preference, vocal range, activity theory, rhythmic training, and reality orientation.

¹²⁰H. F. Galloway, "Stuttering and the Myth of Therapeutic Singing," Journal of Music Therapy 11 (Winter, 1976): 220-227.

¹²¹C. Braswell, C. Maranto and A. Decuir, "A Survey of Clinical Practice in Music Therapy, Part I: The Institutions in Which Music Therapists Work and Personal Data," Journal of Music Therapy 16 (Spring, 1979): 2-16.

Gibbons studied the musical preferences of the elderly in an attempt to determine whether musical preference was a factor in their lives. The results of the study indicated that "elderly persons strongly preferred popular music of their young adult years to popular music of life periods after young adulthood."¹²² In an area related to musical preference, Greenwald and Salzburg¹²³ found that the vocal range of thirty geriatric patients was approximately thirteen semi-tones. The authors also found upon examination of the song books commonly used with geriatric patients, that the range of songs contained in the books were nearly five notes above the vocal range of the patients.

Meseck¹²⁴ found singing and movement activities to be beneficial with chronically ill geriatric patients in improving mental status, social behaviors, and ward behaviors. Martin and Kilgour¹²⁵ used rhythm during ward activities to help energize and improve the physical status of their clients.

¹²²A. C. Gibbons, "Popular Music Preferences of Elderly People," Journal of Music Therapy 14 (Winter, 1977): 180-189.

¹²³A. M. Greenwald and R. S. Salzburg, "Vocal Range Assessment of Geriatric Clients," Journal of Music Therapy 16 (Winter, 1979): 172-179.

¹²⁴N. Martin and W. S. Kilgour, "Music Therapy in Treatment of Chronically Regressed Geriatric Patients," Osteopath Annals 6 (April, 1978): 71-73.

¹²⁵K. Meseck, "An Evaluation of Music Therapy with Geriatric Patients," Journal, Canadian Association for Music Therapy 16 (Winter, 1979): 172-179.

In a more controlled investigation, Riegler utilized a technique called reality orientation "to reverse or halt confusion, social withdrawal, and apathy characteristic of elderly institutionalized patients."¹²⁶ In a program comparing a traditional reality orientation program to a music based RO program, the author found that subjects receiving the music-based treatment "improved in orientation to the environment significantly more than subjects that received only the traditional RO program."¹²⁷ Riegler also studied the effectiveness of a sensory stimulation program to improve environmental awareness. The lesson plans included activities related to self-identification, auditory discrimination and awareness, environmental awareness, and the identification of environmental stimuli. The results of the study revealed music and sensory training to be an effective aid in enhancing sensory abilities of the client.¹²⁸

Clinical Papers

Generally, clinical approaches with geriatric patients have been similar to the research methods already mentioned. Oke¹²⁹ advocated

¹²⁶J. Riegler, "Comparison of a Reality Orientation Program for Geriatric Patients With and Without Music," Journal of Music Therapy 17 (Spring, 1980): 26-33.

¹²⁷Ibid.

¹²⁸J. Riegler, "The Use of Music in a Group Sensory Training Program for Regressed Geriatric Patients," (Master's thesis, Loyola University, 1981).

¹²⁹D. Oke, "Developing Music Stimulation Programmes in Long Term Geriatric Settings," Bulletin, Australian Music Therapy Association 2 (1979): 5-9.

the use of singing and rhythm activities to stimulate long-term clients. Brown¹³⁰ used a music and exercise program to counter the effects of the normal functional deterioration related to aging. Palmer¹³¹ and Allen¹³² presented more comprehensive programs of singing and rhythm band activities, physical training, and reality orientation for their geriatric clients.

Hearing Disorders, Disadvantaged, Penology
and Substance Abuse

The following discussion will utilize a variety of research and clinical references related to hearing disorders, disadvantaged, penology, and substance abuse. The reason for combining these topics is due to the sparcity of literature in each area. It is important that they be cited here because these are areas in which music therapists are currently employed, and have developed research and clinical methods to be used with these clients.

Hearing Disorders

Experimental Papers

It has been stated in the literature that children with hearing

¹³⁰C. Brown, "Assessment of the Effects of Music Therapy in a Geriatric Hospital," Proceedings, First National Conference Australian Music Therapy Association, (August, 1975): 2-5.

¹³¹M. D. Palmer, "Music Therapy in a Comprehensive Program of Treatment and Rehabilitation for the Geriatric Resident," Journal of Music Therapy 14 (Winter, 1977): 190-197.

¹³²D. M. Allen, "Music Therapy with Geriatric Patients," British Journal of Music Therapy 8 (Autumn, 1977): 2-6.

impairments tend to exhibit poor emotional control, feelings of ego-centricity and inferiority.¹³³ Galloway and Bean used action songs to aid in the development of body-image among hearing impaired children. Using six hearing impaired children as subjects, the results indicated "that music may be a useful method in teaching selected concepts to hearing impaired children."¹³⁴ Darrow¹³⁵ compared beat reproduction ability of normal and hearing impaired students using visual and auditory cues. The results of the study indicated that hearing impaired subjects showed greater ability to reproduce beats at eighty-eight beats per second than at sixty beats per second.

Clinical Papers

Clinical methods used by music therapists and special music educators with hearing disorder patients tend to be comprehensive and generally similar. The kazoo was used effectively by Birkenshaw,¹³⁶ while Strathdee¹³⁷ found Kodaly methods helpful. Curricula composed

¹³³H. F. Galloway and M. F. Bean, "The Effects of Action Songs on the Development of Body-Image and Body-Part Identification in Hearing Impaired Preschool Children," Journal of Music Therapy 11 (Fall, 1974): 125-134.

¹³⁴Ibid.

¹³⁵A. Darrow, "The Beat Reproduction Response of Subjects with Normal and Impaired Hearing: An Empirical Comparison," Journal of Music Therapy 16 (Summer, 1979): 91-98.

¹³⁶L. Birkenshaw, "Consider the Lowly Kazoo," Volta Review 77 (October, 1975): 440-444.

¹³⁷H. Strathdee, "Music for Hearing Impaired Children in an Integrating Setting," Bulletin, Australian Music Therapy 3 (February, 1980): 10-12.

of singing games and vocalises, dancing, auditory training, movement exercises, and rhythm awareness through bone conduction were employed by Allen,¹³⁸ Stern,¹³⁹ Fahey and Birkenshaw,¹⁴⁰ Birkenshaw¹⁴¹ and Austin.¹⁴²

Disadvantaged

Experimental Papers

The experimental literature in this area deals with studies on self-esteem and curricula development for slow learners. Michel and Martin¹⁴³ studied the effects of musical training on self-esteem of fourteen adolescent boys. The result of the study was that musical skill development may be beneficial in increasing "the self-esteem of disadvantaged problem students." Eisenstein¹⁴⁴ investigated the use of guitar lessons presented contingently to improve the reading skills

¹³⁸M. Allen, "Educating Through Music - An Innovative Program for Hearing Impaired Children," Volta Review 77 (1975): 381-385.

¹³⁹V. Stern, "They Shall Have Music," Volta Review 77 (1975): 495-500.

¹⁴⁰J. D. Fahey and L. Birkenshaw, "Bypassing the Ear: The Perception of Music by Feeling and Touch," Music Educators Journal 58 (August, 1972): 44-49.

¹⁴¹Birkenshaw, "Consider the Lowly Kazoo," p. 440.

¹⁴²J. Austin, "The Deaf Child," Conference Papers 1971-1976, British Society for Music Therapy, pp. 15-20.

¹⁴³D. E. Michel and D. Martin, "Music and Self-Esteem Research with Disadvantaged, Problem Boys in an Elementary Schools," Journal of Music Therapy 7 (Winter, 1970): 120-127.

¹⁴⁴S. R. Eisenstein, "Effects of Contingent Guitar Lessons on Reading Behavior," Journal of Music Therapy 11 (Fall, 1974): 138-146.

skills of twelve third grade students. The study revealed that contingent guitar lessons increased the subjects' ability to read. Greenberg¹⁴⁵ found that the use of music in the preschool curriculum for head start students was effective. Young¹⁴⁶ also studied the implementation of music in a preschool head start program for disadvantaged children. He found that the "typical head start teacher was capable of producing significant improvement in the musical abilities of pre-school disadvantaged children."¹⁴⁷ Clinically, methods for disadvantaged children have involved the incorporation of music in the curriculum as a primary form of training (Patterson¹⁴⁸).

Penology and Substance Abuse

In a recent survey of the music therapy profession, no registered music therapist was reported as being employed in exclusively penological institutions.¹⁴⁹ The same is true for settings treating

¹⁴⁵M. Greenberg, "A Preliminary Report of the Effectiveness of a Preschool Music Curriculum with Preschool Headstart Children," Council for Research in Music Education: Bulletin, 29 (Summer, 1972): 13-16.

¹⁴⁶W. T. Young, "Efficacy of a Self-Help Program in Music for Disadvantaged Preschools," Journal of Research in Music Education 23 (Summer, 1975): 99-108.

¹⁴⁷Ibid.

¹⁴⁸W. Patterson, "Our Own Thing," Journal of Music Therapy 9 (Fall, 1972): 119-122.

¹⁴⁹Braswell et al., "A Survey of Clinical Practices in Music Therapy, Part I: The Institutions in Which Music Therapists Work and Personal Data," p. 2-16.

substance abuse clients. Consequently, the literature in both penology and substance abuse is sparse.

In an experimental paper, Madsen and Madsen¹⁵⁰ used behavior modification techniques "with a juvenile delinquent." The authors used contingent guitar lessons to modify abusive behaviors of a fifteen year old male. The results indicated that behavior modification was an effective approach for eliminating the problem behaviors of the client. Clinically, Wardle described the musical activities used in a women's prison. The author reported that the activities included sessions of vocal and instrumental improvisation, music listening, and the use of music in psychotherapy.¹⁵¹

In a paper by Watts, some of the characteristics and problems of the elderly alcoholic were recounted. The author stressed the importance of the music therapist being aware and willing to deal with the problems of social isolation.¹⁵² He believed that music should be used to promote social interaction. Smith¹⁵³ employed rhythmic

¹⁵⁰C. K. Madsen and C. H. Madsen, "Music as a Behavior Modification Technique with Juvenile Delinquent," Journal of Music Therapy 5 (Fall, 1968): 72-76.

¹⁵¹M. Wardle, "Music Therapy in a Women's Prison, Part 1: The Old Prison," British Journal of Music Therapy 10 (February, 1979): 11-14.

¹⁵²T. D. Watts, "Understanding the Elderly Alcoholic," British Journal of Music Therapy, 11 (Autumn, 1980): 10-15.

¹⁵³S. M. Smith, "Using Music Therapy with Short-Term Alcoholic and Psychiatric Patients," Hospital and Community Psychiatry 26 (July, 1975): 420-421.

activities with alcoholic patients in short-term treatment facilities.

Bonny and Pahnke¹⁵⁴ and Eagle¹⁵⁵ studied the use of music in combination with LSD therapy. Since music is often "involved significantly as a crucial extra-drug variable," it was combined with other traditional forms of therapy. Bonny and Pahnke wrote that besides total knowledge of the patient's musical history, the fidelity of musical reproduction was important. In a controlled study on LSD-music treatment, Eagle reported familiar music to be important to the success of treatment.

Mental Retardation

In the last twenty years, the employment of music therapists has increased most dramatically in facilities treating the mentally retarded. Braswell et al.,¹⁵⁶ reported that the number of RMT's employed in the various facilities treating the retarded was second only to facilities for psychiatric patients.

According to the American Association for Mental Deficiencies, mental retardation is defined as "subaverage general intellectual functioning which originates during the developmental period and is

¹⁵⁴H. L. Bonny and W. N. Pahnke, "The Use of Music in Psychedelic (LSD) Psychotherapy," Journal of Music Therapy 9 (Summer, 1972): 64-87.

¹⁵⁵C. T. Eagle, "Music and LSD: An Empirical Study," Journal of Music Therapy 9 (Spring, 1972): 23-36.

¹⁵⁶Braswell et al., "A Survey of Clinical Practices in Music Therapy, Part I: The Institutions in Which Music Therapists Work and Personal Data," p. 2-16.

associated with impairment in adaptive behavior."¹⁵⁷ Mental retardation is divided into four general categories according to intelligence quotient (IQ). Briefly, the categories are mild (67-52), moderate (51-35), severe (32-20), and profound (19 and below). The following discussion will be divided into the aforementioned general categories.

Mental Retardation - Mild

A major topic of research concerns the establishment of musical profiles for musical ability and aptitude of the mentally retarded. Also important is a comparison of the ability and aptitude scores of the retarded with those of subjects possessing average intelligence (Bixler,¹⁵⁸ Gordon,¹⁵⁹ and Zenatti¹⁶⁰). Rhythmic ability and vocal range were the research topics of Kaplan¹⁶¹ and Larson,¹⁶²

¹⁵⁷ Herbert Grossman, ed., Manual on Terminology and Classification in Mental Retardation (Washington, D. C.: American Association on Mental Deficiency, 1973), p. 5.

¹⁵⁸ J. Bixler, "Musical Aptitude in the Educable Mentally Retarded Child," Journal of Music Therapy 5 (June, 1968): 41-43.

¹⁵⁹ E. Gordon, "The Use of the Musical Aptitude Profile with Exceptional Children," Journal of Music Therapy 5 (June, 1968): 37-40.

¹⁶⁰ A. Zenatti, "Melodic Memory Tests: A Comparison of Normal Children and Mental Defectives," Journal of Research in Music Education 23 (September, 1975): 41-52.

¹⁶¹ P. R. Kaplan, "A Criterion-Referenced Comparison of Rhythmic Responsiveness in Normal and Educable Mentally Retarded Children," Dissertation Abstracts International A 38:6 (December, 1977): 139-143.

¹⁶² B. A. Larson, "A Comparison of Singing Range of Mentally Retarded and Normal Children with Published Songbooks Used in Singing Activities," Journal of Music Therapy 14 (Fall, 1977): 139-143.

respectively. Larson found that the vocal ranges of MR clients were both lower and narrower than those of normal subjects. Kaplan reported "that the abilities to maintain the beat and to respond to gradual change in tempo were more highly developed than the other rhythmic skills in normal and in retarded clients."

The contingent use of music to modify various forms of maladaptive behaviors was studied by Ritschl, Mongrella, and Presbie,¹⁶³ Steele,¹⁶⁴ Jorgenson,¹⁶⁵ and Cook and Freethy.¹⁶⁶ Greene, Hoats, and Dibble¹⁶⁷ used the aversive effects of distorted music to produce "stable behavior change." A successful token economy program was employed by Dileo.¹⁶⁸ In this study clients were allowed to purchase music listening time with tokens earned by appropriate behaviors in other

¹⁶³C. Ritschl et al., "Group Time-Out from Rock and Roll Music and Out-of-Seat Behavior of Handicapped Children While Riding a School Bus," Psychological Report 31 (December, 1972): 967-973.

¹⁶⁴A. L. Steele, "Effects of Social Reinforcement on the Musical Preference of Mentally Retarded Children," Journal of Music Therapy 4 (June, 1967): 57-62.

¹⁶⁵H. Jorgenson, "The Use of a Contingent Music Activity to Modify Behaviors Which Interfere with Learning," Journal of Music Therapy 9 (Spring, 1974): 41-46.

¹⁶⁶M. Cook and M. Freethy, "The Use of Music as a Positive Reinforcer to Eliminate Complaining Behavior," Journal of Music Therapy 10 (Winter, 1973): 213-216.

¹⁶⁷R. Greene et al., "Generalization of the Aversive Effects of Music Distortion," The Psychological Record 25 (Spring, 1975): 173-180.

¹⁶⁸C. L. Dileo, "The Use of a Token Economy Program with Mentally Retarded Persons in a Music Therapy Setting," Journal of Music Therapy 12 (Fall, 1975): 153-160.

activities. The results indicated that token economy can be used to "increase appropriate behaviors and to decrease inappropriate behaviors of institutionalized mental retardates."

An exploratory study by Staples¹⁶⁹ investigated the use of music in a paired-association task. In an experimental-control group design, the results indicated that significantly more vocabulary was learned when music was used as a mediator. Myers¹⁷⁰ employed the paired-association approach on a retention task. While significance was not achieved in this study, the results did indicate that paired-association could be successful in a retention task.

Concerning the influence of background music on a manual task, Sternlicht et al.¹⁷¹ found that classical music was detrimental to the performance of a complex manual task, while the opposite was true for jazz and popular music. Schoenfeld investigated the effects of background stimuli on the performance of brain-injured and familial retardates. Briefly, the results indicated that musical stimulation

¹⁶⁹S. M. Staples, "A Paired-Associates Learning Task Utilizing Music as the Mediator: An Exploratory Study," Journal of Music Therapy 5 (June, 1968): 53-57.

¹⁷⁰E. Myers, "The Effect of Music on Retention in a Paired-Associate Task with EMR Children," Journal of Music Therapy 16 (Winter, 1979): 190-198.

¹⁷¹M. Sternlicht et al., "Influence of Musical Stimulation Upon the Functioning of Institutionalized Retardates," Psychiatric Quarterly Supplement 41 pt. 2 (1967): 323-329.

enhanced the performance of both groups.¹⁷²

The most frequently mentioned clinical approach with this level of client involved the use of various types of movement activities. Aisenwaser employed Dalcroze methods to accompany a fourteen year old girl's movement exercises.¹⁷³ He also found improvisation to be useful. Groves¹⁷⁴ and van Breda¹⁷⁵ agreed that while physical fitness was a by-product of movement exercises it was not the primary objective. Listening skills, social interaction, body awareness, movement exploration, spatial awareness, and self-expression were the primary goals of music and movement. More diverse special education approaches were employed by Breidenthal,¹⁷⁶ Bennis,¹⁷⁷ and Bullen.¹⁷⁸ Lathom, Edson,

¹⁷²L. Schoenfeld, "Effects of Auditory Stimulation on the Performance of Brain-Injured and Familial Retardates," Perceptual and Motor Skills 31 (1970): 139-144.

¹⁷³V. de Aisenwaser, "Music Therapy with a Mentally Deficient Girl," British Journal of Music Therapy 6 (Summer, 1975): 2-8.

¹⁷⁴L. Groves, "Music, Movement and Mime," Nursing Times 64 (March, 1968): 295-297.

¹⁷⁵H. van Breda, "Developing Mentally Handicapped Children Through Movement Activities," The Australian Music Therapy Association Bulletin 3 (March, 1980): 13-16.

¹⁷⁶M. Breidenthal, "The Music Therapist as Special Educator in the Public Schools," in Music Therapy 1958 ed. E. H. Schneider (Lawrence, Kansas: National Association for Music Therapy, 1959) p. 87-93.

¹⁷⁷D. Bennis, "The Use of Music as a Therapy in the Special Education Classroom," Journal of Music Therapy 6 (Spring, 1969): 15-18.

¹⁷⁸D. Bullen, "Effects of Music Activities on Groups with Special Needs in the Comox Valley," The Journal, Canadian Music Therapy Association 1 (Winter, 1976): 7-8.

and Toombs¹⁷⁹ combined music and speech activities into a single program. Music was used to teach words and phrases as well as to mix words and phrases with increasing complexity.

Mental Retardation - Moderate

The category of "moderate" retardation corresponds roughly to the educational grouping of "trainable" (25-50 IQ). In general the goals for these clients are further broadening of self-help skills, social skills, a degree of financial independence, and some academic training.

Experimentally, the successful application of behavioral techniques has been cited frequently in the literature to achieve some of the goals appropriate for moderately retarded clients. Bellamy and Sontag¹⁸⁰ found that music presented "episodically and conjugately provided an effective means of accelerating the assembly line production rates of retarded students." Ball, McCrady, and Hart¹⁸¹ revealed that music presented contingently could increase the amount of time two cerebral palsied retarded children held their heads erect.

¹⁷⁹W. Latham et al., "A Coordinated Speech Therapy and Music Therapy Program," Journal of Music Therapy 2 (Winter, 1965): 1-8.

¹⁸⁰T. Bellamy and E. Sontag, "Use of Group Contingent Music to Increase Assembly Line Production Rates of Retarded Students in a Simulated Sheltered Workshop," Journal of Music Therapy 10 (Fall, 1973): 125-136.

¹⁸¹T. Ball et al., "Automated Reinforcement of Head Posture in Two Cerebral Palsied Retarded Children," Perceptual and Motor Skills 40 (April, 1975): 619-622.

The same technique was employed by Cotter¹⁸² to increase the rate of work accomplished on a manual task. Other behavioral techniques which have been successful experimentally are the Premack Hypothesis (Talkington and Hall¹⁸³), stimulus fading, and schedule learning (Johnson and Zinner¹⁸⁴).

Descriptive studies were undertaken to determine response modes of retarded clients to various stimuli. Some of these topics included vocal ranges of institutionalized mental retardates (Dileo¹⁸⁵), musical sensitivity (Peters¹⁸⁶), auditory discrimination abilities (Humphrey¹⁸⁷), rhythmic perception (Lienhard¹⁸⁸), and instrumental

¹⁸²W. Cotter, "Effects of Music on Performance of Manual Tasks with Retarded Adolescent Females," American Journal of Mental Deficiency 76 (September, 1971): 242-248.

¹⁸³L. Talkington and S. Hall, "A Musical Application of Premack's Hypothesis to Low Verbal Retardates," Journal of Music Therapy 7 (Fall, 1970): 95-99.

¹⁸⁴J. Johnson and C. Zinner, "Stimulus Fading and Schedule Learning in Generalizing and Maintaining Behaviors," Journal of Music Therapy 11 (Summer, 1974): 84-96.

¹⁸⁵C. L. Dileo, "The Relationship of Diagnostic and Social Factors to the Singing Ranges of Institutionalized Mentally Retarded Persons," Journal of Music Therapy 13 (Spring, 1976): 17-27.

¹⁸⁶M. Peters, "A Comparison of the Musical Sensitivity of Mongoloid and Normal Children," Journal of Music Therapy 7 (Winter, 1970): 113-123.

¹⁸⁷T. Humphrey, "The Effect of Music Ear Training Upon the Auditory Discrimination Abilities of Trainable Mentally Retarded Adolescents," Journal of Music Therapy 17 (Summer, 1980): 70-74.

¹⁸⁸M. Lienhard, "Factors Relevant to the Rhythmic Perception of a Group of Mentally Retarded Children," Journal of Music Therapy 13 (Summer, 1976): 58-65.

music preference (Aldridge¹⁸⁹).

Clinical Papers

Comprehensive educational programs through the use of musical activities have been described by Gordon,¹⁹⁰ Segenthaler,¹⁹¹ Jorgenson and Parnell,¹⁹² and Isern.¹⁹³ These authors presented activities programs which included private lessons in improvisation, singing lessons, rhythm band, and dance activities. Goodnow¹⁹⁴ described how dance activities could be modified and used effectively with the various functioning levels of retarded clients. The activities model was also used by Slowo¹⁹⁵ in conjunction with video-taped feedback. The author found that the use of video-taped lessons was both educational and

¹⁸⁹C. Aldridge, "Choice of Rhythm Instruments and the Use of Rhythm Band Scores by TMR Adult Females," Mental Retardation (April, 1979): 89-90.

¹⁹⁰B. L. Gordon, "Music Therapy for Moderately and Severely Retarded School Children," The Journal, Canadian Association for Music Therapy 6 (1978): 21-24.

¹⁹¹M. Segenthaler, "Work with ESS Patients," British Journal of Music Therapy 10 (September, 1979): 2-6.

¹⁹²H. Jorgenson and M. Parnell, "Modifying Social Behaviors of Mentally Retarded Children in Music Activities," Journal of Music Therapy 7 (Fall, 1970): 83-87.

¹⁹³B. Isern, "Music in Special Education," Journal of Music Therapy 1 (December, 1964): 139-142.

¹⁹⁴C. Goodnow, "The Use of Dance in Therapy with Retarded Children," Journal of Music Therapy 5 (December, 1968): 97-102.

¹⁹⁵N. Slowo, "Music Therapy for Children with Special Needs," Proceedings, Second National Conference, Australian Music Therapy Association (August, 1976): 45-49.

therapeutic for parents, teachers, and children.

Mental Retardation - Severe and Profound

The remaining two categories in which mental retardates are classified are different from the two categories already discussed in terms of functioning ability. Self-help skills and social functioning are the primary goals. However, at the profound level, goals and objectives are established to help retard physical effects due to complicating illnesses. Cerebral palsy is an illness typically associated with the severe and profound levels of retardation.

Music has been used experimentally in various reinforcement formats to decrease the incidence of body-rocking behaviors (Hollis,¹⁹⁶ Greene, Hoats and Hornick,¹⁹⁷), tics (Jorgenson¹⁹⁸), and aggressive behaviors (Humphrey¹⁹⁹). Other researchers have successfully applied these techniques to increase imitative behaviors (Dorow,²⁰⁰

¹⁹⁶J. Hollis, "Body-Rocking: Effects of Sound and Reinforcement," American Journal of Mental Deficiency 75 (March, 1971): 642-644.

¹⁹⁷R. Greene et al., "Music Distortion: A New Technique for Behavior Modification," The Psychological Record 20 (1970): 107-109.

¹⁹⁸H. Jorgenson, "Effect of Contingent Preferred Music in Reducing Two Stereotyped Behaviors of a Profoundly Retarded Child," Journal of Music Therapy 8 (Winter, 1971): 139-145.

¹⁹⁹T. Humphrey, "The Use of Continuous and Contingent Background Music to Decrease Occurrences of Aggressive Behavior Among Profoundly Retarded Young Adults," New Orleans, 1980. (Mimeographed.)

²⁰⁰L. Dorow, "Conditioning Music and Approval as New Reinforcers for Imitative Behavior with the Severely Retarded," Journal of Music Therapy 12 (Spring, 1975): 30-39.

Metzler²⁰¹).

A variety of descriptive studies have been undertaken to establish a broad musical and behavioral profile of the severe and profoundly retarded client. Reardon and Bell²⁰² investigated activity levels of retarded boys under conditions of stimulative and sedative music. The results seem to indicate that activity levels varied inversely with stimulative music. Decuir,²⁰³ investigating vocal responsiveness of severe and profound retardates to four musical instruments, found that the clients responded better to the piano than to the pipe organ, electronic organ, or guitar.

Orff-Schulwerk methods were used to foster imitation ability (Bitcon and Ball²⁰⁴) while working on gross and fine motor skills. Saperston²⁰⁵ used piano to accompany walking, stomping, rocking, shuffle steps, and hand pounding behaviors.

²⁰¹R. Metzler, "The Use of Music as a Reinforcer to Increase Imitative Behavior in Severely and Profoundly Retarded Female Residents," Journal of Music Therapy 11 (Summer, 1974): 197-210.

²⁰²D. Reardon and G. Bell, "Effects of Sedative and Stimulative Music on Activity Levels of Severely Retarded Boys," American Journal of Mental Deficiency 75 (1970): 156-159.

²⁰³A. Decuir, "Vocal Responses of Mentally Retarded Subjects to Four Musical Stimuli," Journal of Music Therapy 12 (Spring, 1975): 40-43.

²⁰⁴C. Bitcon and T. Ball, "Generalized Imitation and Orff-Schulwerk," Mental Retardation 12 (June, 1974): 36-39.

²⁰⁵B. Saperston, "The Use of Music in Establishing Communication with an Autistic Mentally Retarded Child," Journal of Music Therapy 10 (Winter, 1973): 184-188.

Summary

The related literature presented in this chapter was divided into two general areas. The first section dealt with research statements taken from the twelve music therapy yearbooks. Since the yearbooks served as a chronology of formation and development of NAMT, it was important to reiterate the sentiments of the founders of NAMT concerning the importance of research and experimentation to the development of the music therapy profession.

The second part of the chapter presented a survey of clinical and experimental papers in adult and child psychiatry, physical disabilities, geriatrics, hearing disorders, disadvantaged, penology, substance abuse, and mental retardation. The experimental and clinical research articles discussed are related to the influence of music on human behavior. More importantly, the literature highlights areas where experimental and clinical papers are needed, and the research skills required to meet this need.

CHAPTER III

REVIEW AND COURSE UNITS

Each unit will be independent, containing an overview, a detailed methodology with the computation applied to an example from music therapy literature, and a computer program(s). At the end of each unit, there will be a set of exercises and instructions for their completion. Also appearing at the end of each unit will be references for additional information.

The exercises will be due one week after the unit is introduced in class. It is important that the student consult with the instructor throughout the course; it is particularly important that the student advise the instructor of any difficulties encountered in the process of completing a unit. The review and course units appear as Table 2. Students will be required to complete successfully the first seven Course Units as well as the Review Units.

Table 1
Grading Policy

Course Units Completed	Grade
10	A
9	B+
8	B
7	B-
6 and below	I

Table 2
Review and Course Units

<u>Review Units</u>	
1	Experimental Design and Research Terminology - 1st Week and 2nd Week
2	Introduction to the Computer Terminal - 3rd Week
3	The t-test - 4th Week
4	Simple One-Way Analysis of Variance: Completely Randomized Design - 5th Week
<u>Course Units</u>	
1	Analysis of Variance: Factorial Designs - 6th Week
2	Analysis of Variance: Treatment Designs - 7th Week
3	Analysis of Variance: Mixed Designs - 8th Week
4	Analysis of Covariance - 9th Week
5	Multiple Correlation and Regression - 10th Week
6	Discriminant Function Analysis - 11th Week
7	Non-parametric Statistics: Test of Goodness-of-Fit - 12th Week
8	Non-parametric Statistics: Tests for Two Independent Samples - 13th Week
9	Non-parametric Statistics: Tests for Correlated Samples - 14th Week
10	Non-parametric Statistics: Tests for More than Two Groups - 15th Week

Review Unit 1

1.0 Experimental Design

Experimental design is the plan employed to carry out an experiment. Kerlinger delineates the various stages in the realization of an experiment as the plan, the structure, and the strategy. He defines the plan as a general scheme, the structure as the operation of the variables, and the strategy as the methodology.²⁰⁶

In addition to answering the questions posed by the researcher, the other important purpose of the experimental design is to control for sources of variability. This process must be stressed since the inability to control variance will preclude the answering of any research question. Kerlinger describes this control of variability in terms of maximizing the difference between the dependent and independent variable.²⁰⁷ More specifically, it refers to the variance of the dependent variable as caused by the independent variable. The influence of the independent variable on the dependent variable is made clearer by the control of extraneous variables.

There are two primary methods of dealing with extraneous variables, selection and randomization. Their effects might be eliminated by selecting subjects with regard to the independent variable.

²⁰⁶ Fred N. Kerlinger, Foundations of Behavioral Research, 2nd ed. (New York: Holt, Rinehart and Winston, Inc., 1973), pp. 309-311.

²⁰⁷ Ibid.

Although this method is effective, what is gained in the way of control is later lost when the experimenter attempts to generalize his findings to groups not examined. Perhaps the most widely accepted method used for controlling extraneous variability is randomization. Randomization spreads the extraneous variance over both the experimental and control groups. Randomization, however, cannot be relied upon to control the sources of variance when the number of observations is small. The elimination or limiting of error variance is another method of controlling extraneous variables. Random errors, though unpredictable, usually balance out to zero. Sources of error variance are the individual differences among the subjects and measurement error. Error variance is limited by controlling conditions under which the data are collected and by increasing the reliability of the measurement. Sources of error variance can be summarized as follows: total variability is equal to variability between the groups and variability due to error.

Stanley and Campbell²⁰⁸ mention several factors which effect the validity of an experiment. Internal validity attempts to determine whether the experimental treatment caused a change in the dependent variable; external validity, on the other hand, is defined as the degree to which the results can be generalized to a population or group

²⁰⁸ Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research (Chicago: Rand McNally and Company, 1963), p. 5.

of individuals other than those actually used in the study. While external validity can only be assumed, internal validity is the bare minimum for interpreting an experiment. The factors effecting internal validity are:

1. History - events which occur in the course of the experiment that might influence the effects of the experimental variable
2. Maturation - physiological changes in the subject which occur during the course of collecting the data
3. Testing - effects due to the first testing on the subsequent testing
4. Statistical regression - effects due to the selection of subjects on the basis of extreme test scores. Additionally, extreme scores tend to move toward the average with subsequent testing
5. Selection - the selection of subjects may be biased
6. Experimental mortality - loss of subjects in an experiment due to any number of reasons²⁰⁹

The influences which effect generalizability or external validity are more subtle, involving factors which could possibly make the responses of the experimental subjects unique. For example, in multi-treatment experiments, there may be residual effects due to prior treatment, or experimental subjects might be sensitized to the treatment.

1.1 Types of Research Designs

The experimental design is a blueprint which enables an experimenter to answer his research questions. Some of the designs to be

209

Ibid.

discussed are examples of poor research designs that provide little in the way of answering research questions validly, but, which nevertheless, often appear in the literature.

Using the symbols provided by Stanley and Campbell where X represents exposure to an experimental treatment and 0 an observation or measurement, the following are examples of poor experimental designs:

1. Simply represented

X

This design represents the substitution of one method with another assuming that the replacement is somehow better. No observations or measurements are made.

2. An alternative to #1 is

X 0

the "One Shot Case Study," provides a measurement of the observed effects of a treatment, though we have a measurement we have no frame of reference.

3. Still another alternative of #1 is the use of a pre-test into the experiment.

$$0_1 \times 0_2$$

Perhaps this design is more dangerous because an eager experimenter might attribute change from O_1 to O_2 to X.

Extraneous variables other than the treatment (X) may have occurred during the time.

4. Stanley and Campbell refer to the following as the "Static-Group comparison."

$$\frac{x}{0_1} - \frac{0_2}{0_1}$$

Here two groups are selected with one receiving the treatment and the results measured. The difficulty is that the groups can only be assumed to be equivalent. (The dashes represent the non-equivalent status of the groups.)

Three Good Experimental Designs

5. One of the most widely used designs is expressed by Stanley and Campbell as follows, where R represents randomization:

$$R \quad O_1 \quad X \quad O_2$$

$$R \quad O_3 \quad \quad O_4$$

The groups are selected on the basis of random selection. Since this is the first design in which randomization is featured an additional comment is warranted. Randomization means that in terms of assigning subjects to either experimental or control groups all subjects have an equal chance of being assigned to either group. Matching by comparison, requires that variables on which the subjects are matched must be rather substantially related to the independent variable. Additionally, as the number of variables is increased on which the subjects are matched, mortality becomes a crucial factor. In conclusion, the authors write that matching in no way replaces randomization, but is used in conjunction with randomization.

6. The Solomon Four-Group Design is an extension of the previously mentioned design. This design

$$R \quad O_1 \quad X \quad O_2$$

$$R \quad O_3 \quad \quad O_4$$

$$R \quad \quad X \quad O_5$$

$$R \quad \quad \quad O_6$$

controls for generalizability. While no statistical device can assess the results of all six observations, a 2 X 2 analysis of variance could be used. The analysis will be covered in depth in a later unit.

$$\begin{array}{cc} 0_4 & 0_2 \\ \hline 0_6 & 0_5 \end{array}$$

7. The following design highlights the importance and strength of randomization. Notice no pre-test is used. The pre-test is not needed because randomization is used, thus eliminating at least one threat to validity.²¹⁰

R X 0₁

R 0₂

1.2 Research Terminology

The purpose of this section is to review the terms most commonly associated with statistics and experimental design. It is necessary that the student have a working knowledge of these terms since, in most instances, these terms combine to provide a unified picture of research, experimental design, and statistics.

Research Terminology

Baseline	Gaussian curve
Bias	Measures of central tendency
Design	mean
completely randomized	mode
correctional	median
descriptive (normative)	Group(s)
experimental	experimental
factorial	control
Latin square	Hypotheses
mixed	alternate
multivariate	
pre-test/post-test	

²¹⁰Ibid.

Design (cont'd.)	Hypotheses (cont'd.)
quasi-experimental design	experimental
time series design	null
treatment-by-levels	
treatment-by-subjects	Mortality
(repeated measures)	
	Parameter
Dispersion	
range	Paradigm
standard deviation	
	Population
Experimental control	
	Randomization
Skew	
	Reliability
Kurtosis	
	Response
Sample	amplitude
	duration
Sources of Variance	error
between groups	frequency
within groups	latency
Statistics	Validity
descriptive	external
inferential	internal

1.3 Scales and Measurement

Measurement involves the assigning of numbers to people, objects, events, or occurrences in nature. The manner in which these numbers are assigned is called the scale. There are four scales concerned in this assignment. They are: (1) nominal, (2) ordinal, (3) interval, and (4) ratio.

A nominal scale is the most fundamental, and involves assigning numbers to objects or events. An example of a nominal scale would be the numbers assigned to players on a football team. Another example would be identifying musical instruments by number where piano = 1,

guitar = 2, and autoharp = 3. The nominal scale is suited only for use with non-parametric statistical devices, a topic to be discussed in units 7 through 10.

The next level of scalar measurement is the ordinal scale. The ordinal scale permits the ordering as well as ranking of events, objects, etc. For example, the scores of clients on a rhythm perception test: 96, 93, 88, 84, 78 might be ranked 1, 2, 3, 4, 5. Or, a professional panel of music therapists might rank the clinical performances of clinical training students from 1 to 10. The ordinal scale also is suited for non-parametric statistics.

The equal-interval scale allows treatment of data by fundamental arithmetic functions such as addition, subtraction, multiplication, and division. The intervallic scale is so named because the distances between adjacent values on the scale are equal. For example, the distance between a score of 70 and 80 is equal to the distance from 60 to 70. Most standardized tests are based on intervallic data.

Assignment:

Find as many of the designs described in this section (1.1) as you can. Remember these are all experimental research examples and not descriptive research. Use your favorite journals.

For the terms, prepare for a comprehensive discussion of the terms during the next class period.

For additional reading consult:

Huck, Schuyler W.; Cormier, William H.; and Bounds, William G.

Reading Statistics and Research. New York: Harper and Row
Publishers, 1974.

Kerlinger, Fred N. Foundations of Behavioral Research. 2nd ed.
New York: Holt, Rinehart and Winston, Inc., 1973.

Madsen, Clifford, and Madsen, Charles. Experimental Research in
Music. Raleigh, N. C.: Contemporary Publishing Co., 1978.

Review Unit 2

The computer at Loyola University is the Hewlett Packard 3000. The HP 3000 is used not only by students in this course and many other students across campus, but also for most University services. The name and specifications of the computer are unimportant; material presented in this unit and throughout the course are compatible with any centralized computer system.

At the beginning of the course the instructor will give you your username, account, and password. These items are essential for being able to log-on the computer. Please note that you must remember the information as it is not provided by the computer. To be recognized as a valid user by the computer, your username, account, and password must be presented accurately to the computer, that is, misspelled words or omissions will result in an unsuccessful log-on. A complete guide to the computer will be given to you at the beginning of the semester.

Please observe the following steps in using the computer terminal.

STEP 1. Press Return Key to get a colon (:), a system prompt.

If you cannot get a colon (:), call a staff member. There usually is a staff member in or near the room. If using the terminal in the College of Music, see Dr. Decuir.

STEP 2. Type HELLO, leave a space, type your username, then a period, then the account name; do not space between period and account name. For example: HELLO SAHUC.MTVIII Next,

press the RETURN key.

STEP 3. The computer will ask for your password. Be careful to type it correctly. Your password will not appear on the screen.

STEP 4. Any errors to this point will hamper attempts to log-on, and will force you to begin at Step 1 again.

Note that when you log-on the screen will display the date, time, and possibly messages from the management of the Computer Center.

STEP 5. For our purposes, the EDITOR portion of the computer will be most frequently used. In order to access EDITOR, type the word EDITOR to the colon prompt after logging-on. The EDITOR prompt is the (/).

STEP 6. /ADD

The above command will instruct the computer to add numbered lines.

STEP 7. Type the data into the computer as it appears on the sample problems.

STEP 8. Once you have entered the complete data, and wish to stop adding lines, type two slashes (/).

STEP 9. It will be necessary for you to name the file and instruct the editor to keep it. In response to the next editor prompt (/), type KEEP, followed by a space and a filename. The name you choose should have no more than

eight (8) characters. Filenames can contain either letters or numbers, or a combination of both but must begin with a letter. Since you will be adding both DATA files and RUN files (instruction for analyzing the data), it is convenient and facilitates remembering the names of the files by pairing them. For example, if you are filing data from a study on hospices, you might call the data "HOSFDATA." The analysis or "RUN" might be called "HOSPRUNN" (the extra "N" is simply for pagination).

STEP 10. After you have added all the information, you might wish to modify a line in the text. To execute a modification type MODIFY or simply M after the single slash (/) and the number of the line you wish to modify. For example:

/M 1 will cause line 1 to be displayed for change.

/M 1/10 will cause lines 1 through 10 to be displayed successively for modification

/M 1, 2, 5 will cause lines 1, 2, and 5 to be displayed successively for modification

After you have made the necessary modifications, you must press the RETURN button twice in succession to remove the MODIFY command.

STEP 11. To delete a line or lines in the file, after the slash (/) type D 1 or D 10/20. In the first case D 1 will delete line 1, and D 10/20 will delete lines 10 through 20.

STEP 12. After you have modified your file it will be necessary to keep the material file: type KEEP filename, UNN. For Example: KEEP HOSPDATA, UNN will save this information for you until the end of the semester.

STEP 13. To leave the EDITOR, type E after the slash (/) prompt. This brings you back to the INTERPRETER. Recall that you are in the INTERPRETER immediately after logging-on, and before you log-off it is necessary to return to the INTERPRETER.

STEP 14. The HELP command in the EDITOR will list the commands in the EDITOR. In response to an EDITOR prompt (/), type HELP. If you need further assistance please seek a staff member.

STEP 15. The command LIST ALL in the EDITOR will display the names of all of the files in the EDITOR.

STEP 16. In order to be a hard copy of your analysis, it is necessary to type the command LIST ALL LP (lineprinter).

STEP 17. Once the command to LINEPRINTER is issued, your work will begin printing on the lineprinter.

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES:
SPSS

The statistical programs in this package were developed for the social sciences by Nie, Hull, Jenkins, Steinbrenner, and Bent.

The manual will be on reserve in the music library or you can obtain your own from most campus bookstores. The complete manual is quite large and much of the information contained in it is not applicable for this course. Go to specific areas of the manual for the information you desire.

Remember, the use of statistical packages does not preclude your responsibility as a researcher for using the appropriate statistical procedures. SPSS contains a large number of statistics, with many options in each statistical analyses; it is up to the researcher to select the appropriate statistics and options.

The computer can be a very efficient and time-saving device when competently used. Certain statistics might best be computed on a microcomputer or pocket calculator while others can be done only on the computer. It is important that the student practice using the computer, and, as a musician, the idea of practice should not be foreign.

In order for the computer to read your data, the data files must be in the form of a data matrix. Dayton defines a matrix as a simple "rectangular array of algebraic quantities."²¹¹ In the data matrix, each row is a single subject and each column is a different variable. For example, ten subjects were randomly assigned to two groups and administered the rhythm subtest of the Seashore Measures

²¹¹C. Mitchell Dayton, The Design of Educational Experiments (New York: McGraw-Hill, 1970), p. 353.

of Musical Talent. Notice the subjects are on the left and their scores are on the right. Also, the first two digit number represents the subjects' scores on the test (the dependent variable), there is a space, and the single digit represents the group to which they were assigned (the independent variable).

```

29 1
28 1
30 1
27 1
25 1
10 2
15 2
14 2
13 2
17 2

```

The instructions for analysis of the above data are given on the RUN files. Instructions on how to prepare RUN files are given in the SPSS manual. Samples are provided at the end of most of the Review and Course Units. Each file has a series of "cards" which identify the data file, its parameters, and instructions for analyzing the data. These cards differ slightly for each statistical operation. The reference to "cards" was made because SPSS programs were written to run computer cards. The computer must treat the RUN files as though they are cards.

The SPSS Update contains the most recent releases of procedures and facilities provided by SPSS. The Update is also important to us because, except for chi square which is contained in the SPSS Manual, all of the non-parametric statistical devices reviewed in the course

are contained in the SPSS Update. Repeated measures of analysis of variance, a very lengthy and tedious manual operation, also is contained in the Update. The SPSS Update also will be on reserve in the music library.

In conclusion, learning to use the computer terminal is 10% inspiration and 90% perspiration. It requires practice.

Review Unit 3

t-Test

The t-test is one of the most widely used devices for comparing the differences between two means. It is a parametric device. The assumptions underlying its use are that the groups have equal variance, that the data are normally distributed, and that the measurement must at least be intervallic. In the forthcoming discussion, we will preview the uses of the t-test under the following circumstances: the differences between the sample and the population means, differences between independent means, and differences between correlated or related means.

3.0 t-Test for Sample and Population Means

The t-test used to compare a sample mean and a population mean may be computed when the researcher knows both the population's mean or some theorized value and the mean of his sample. The premise that the researcher is working under is whether a drawn sample is significantly different from the population.

3.1 Methodology

Utilizing the formula

$$t = \frac{\bar{X}_s - \bar{X}_p}{\sqrt{\frac{\bar{X}_s^2 - \frac{X^2}{N}}{N(N-1)}}$$

\bar{x}_s = sample mean

\bar{x}_p = population mean (known or theoretical)

N = number of scores in the sample

$\sum x_s^2$ = sum of all scores

$(\sum x_s)^2$ = sum of all the scores, quantity squared

For example, a researcher might be interested in studying the effects of preferred background music on the amount of weight gained by anorexic patients. The following scores are the amounts of weight gained by a random sample of clients.

Table 3
t-Test Data

Subjects	Weights (lbs.)	x^2
s_1	10	100
s_2	12	144
s_3	9	81
s_4	16	256
s_5	8	64
s_6	6	36
s_7	17	289
s_8	13	169
s_9	14	196
s_{10}	15	225

Table 3--Continued

Subjects	Weights (lbs.)	x^2
S_{11}	6	36
S_{12}	8	64
S_{13}	9	81
S_{14}	10	100
S_{15}	$\frac{10}{163}$	$\frac{100}{1941}$

STEP 1. The scores are first listed as in the example.

STEP 2. Add the scores ($10 + 12 + 9 \dots$) = 163

STEP 3. Square each score and sum the result:

$$(10^2 + 12^2 + 9^2 \dots) = 1941$$

STEP 4. Square the sum of the scores of Step 2 ($163^2 = 26,569$) and divide by the number of individual scores (in our example 15).

$$163^2 = 26,569/15 = 1771.27$$

STEP 5. Subtract the result of Step 4 from Step 3, here

$$1941 - 1771.27 = 169.73$$

STEP 6. Divide the result of Step 5 (169.73) by the quantity

$N(N-1)$ Or 15 (15-1). In our example,

$$169.73/210 = 81$$

STEP 7. Compute the square root of the value in Step 6. Here,

$$\sqrt{169.73/210} = \sqrt{.81} = .9$$

STEP 8a. Compute the mean (average) of the sample by adding each score (Step 2) and dividing by the number of scores used.

Here,

$$163/15 = 10.87$$

As already mentioned, the t-test comparing the sample and population means requires that the population mean be known or at least theorized. Having drawn the sample from the hospital population, the mean value in our example is 15.6.

STEP 8b. Subtract the sample mean from the mean of the population:

$$\bar{X}_s - X_p = 10.87 - 15.6 = -4.73$$

STEP 9. Divide the result of Step 8b by Step 7. Here,

$$-4.73/.9 = -5.26^*$$

STEP 10. To determine the significance of t, the degrees of freedom must be known. Here, degrees of freedom equal N - 1. Here 15 - 1 = 14.

*The negative value of t is of no consequence to the significance of t since the absolute value of t is required.

The formula with the necessary substitutions appears as follows:

$$t = \frac{\bar{X}_s - \bar{X}_p}{\sqrt{\frac{\frac{X^2}{N} - \frac{(\sum X)^2}{N^2}}{N(N-1)}}$$

$$= \sqrt{\frac{\frac{10.87^2 - 15.6^2}{1941 - 15}}{15(15 - 1)}}$$

$$= \sqrt{\frac{-4.73}{\frac{169.73}{210}}}$$

$$t = \sqrt{\frac{-4.73}{.81}}$$

$$t = 5.26$$

3.2 t-Test for Two Independent Means

The t-test for two independent means is computed similarly to the previous test. In the case of two independent means however, the comparison is between two separate and independent samples rather than a population. The researcher is attempting to determine whether the scores of two samples differ significantly. The experimental and control group studies are typically analyzed by this method. Some

types of experiments using the t-test for independent means are: traditional versus exploratory educational, medical or training programs. Again, having randomly assigned subjects to experimental and control groups, it does not matter whether the control group is treated as a control group or a second experimental group. Intervallic data must be used.

3.3 Methodology

The t-test for two independent means is calculated by the following formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left[\frac{\sum X_1^2 - \frac{(\sum X_1)^2}{N_1}}{N_1} + \frac{\sum X_2^2 - \frac{(\sum X_2)^2}{N_2}}{N_2} \right] \cdot \left[\frac{1}{N_1} + \frac{1}{N_2} \right]}}$$

where \bar{X}_1 = mean of the first sample

\bar{X}_2 = mean of the second sample

$\sum \bar{X}_1^2$ = sum of all the squared scores in the first sample

$(\sum X_1)^2$ = sum of all the scores in the first sample quantity squared

$\sum X_2^2$ = sum of all the squared scores in the second sample

$(\sum X_2)^2$ = sum of all scores in the sample quantity squared

N_1 = total number of scores in the first sample

N_2 = total number of scores in the second sample

For example, an experimenter is interested in determining whether cent differences exist in the pitch reproduction abilities of a random sample of mentally retarded clients who participated in planned music therapy activities and those who did not. The following data were realized, and represent cent differences from a standard pitch.

Table 4
Cent Differences in Pitch Reproduction

Sample 1 (M.R.'s in Therapy)			Sample 2 (M.R.'s not in Therapy)		
S's	Cents	χ^2	S's	Cents	χ^2
S ₁	5	25	S ₁₆	9	81
S ₂	4	16	S ₁₇	10	100
S ₃	6	36	S ₁₈	11	121
S ₄	3	9	S ₁₉	12	144
S ₅	2	4	S ₂₀	13	169
S ₆	6	36	S ₂₁	14	196
S ₇	7	49	S ₂₂	15	225
S ₈	4	16	S ₂₃	10	100
S ₉	3	9	S ₂₄	11	121
S ₁₀	8	64	S ₂₅	8	64
S ₁₁	5	25	S ₂₆	9	81
S ₁₂	6	36	S ₂₇	<u>10</u>	<u>100</u>
S ₁₃	4	16		132	1502
S ₁₄	2	16			
S ₁₅	<u>5</u>	<u>25</u>			
	70	370			

STEP 1. Arrange the scores as above.

STEP 2. Sum the scores in the samples.

$$(5 + 4 + 6 \dots) = 70$$

STEP 3. Square each score in sample one, and sum the squares.

$$(25 + 16 + 36 \dots) = 370$$

STEP 4. Square the results of Step 2.

$$(70^2 = 4900)$$

Divide by the number of scores in the sample.

$$4900/15 = 326.67$$

STEP 5. Subtract the result of Step 3 from Step 4.

$$326.67 - 370 = -43.33^*$$

STEP 6. Repeat Steps 2 through 5 for the second sample.

STEP 6a. Sum the scores of the second sample.

$$(9 + 10 + 11 \dots) = 132$$

STEP 7. Square each score in the second sample.

$$(81 + 100 + 121 \dots) = 1502$$

STEP 8. Square the results of Step 6.

$$(132^2 = 17,424)$$

Divide the result by N_2 or the number of scores in group two.

$$N_2 = 12$$

$$17,424/12 = 1452$$

STEP 9. Subtract the results of Step 7 from Step 8.

$$1452 - 1502 = -50$$

STEP 10. Add Steps 5 and 9.

$$(-43.33) + (-50) = 93.33$$

STEP 11. Divide the result of Step 10 by the quantity $(N + N) - 2$.

$$(15 + 12) - 2 = 25$$

$$-93.33/25 = -3.73$$

STEP 12. Having obtained the results of Step 11, multiplying: this

$$\text{value by } \frac{1}{N_1} + \frac{1}{N_2} .$$

$$\frac{1}{15} + \frac{1}{12} = .07 + .08 = .15$$

$$.15 \times -3.73 = -.56$$

STEP 13. Compute the square root of Step 12.

$$.56 = .75$$

STEP 14. Compute the means of samples 1 and 2.

$$70/15 = 4.67; 132/12 = 11$$

STEP 15. Subtract the mean of Sample 1 and Sample 2.

$$4.67 - 11 = -6.33^*$$

STEP 16. To obtain t , divide the value of Step 15 by Step 13.

$$t = -6.33/.75 = -8.44$$

STEP 17. To determine the significance of t , first compute the degrees of freedom (df) $N + N - 2$.

$$(15 + 12) - 2 = 25$$

The obtained $t = -8.44$ is significant beyond the .001 level of confidence for the two-tailed test.

*Again, please note that only absolute values are used.

TABLE 5

"Run" file entitled TTESTRUN; "data" file entitled TTESTDAT

```

1      !JOB TONY/ .DECUIR
2      !RUN SPSS.PUB.SPSS
3      RUN NAME      T-TEST SAMPLE PROBLEM
4      VARIABLE LIST  CENTS, GROUP
5      INPUT MEDIUM  DISC(TTESTDAT)
6      N OF CASES     24
7      INPUT FORMAT   FIXED(F2.0,X,F1.0)
8      T-TEST         GROUPS=12,12/VARIABLES=CENTS
13     FINISH
14     !EOJ

```

1	05	1
2	04	1
3	06	1
4	03	1
5	02	1
6	06	1
7	07	1
8	04	1
9	03	1
10	08	1
11	05	1
12	06	1
13	09	2
14	10	2
15	11	2
16	12	2
17	13	2
18	14	2
19	15	2
20	10	2
21	11	2
22	08	2
23	09	2
24	10	2

Note that both files are numbered. The "data" file has twenty-four cases. The center column of two digit numbers is the raw data and the third column of numbers is the group identification code.

TABLE 6

T - T E S T

<hr/>				
GROUP 1 - FIRST 12 CASES				
GROUP 2 - NEXT 12 CASES				
VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR

CENTS				
GROUP 1	12	4.9167	1.782	.514
GROUP 2	12	11.0000	2.132	.615
POOLED VARIANCE ESTIMATE				
	T	DEGREES OF	2-TAIL	
	VALUE	FREEDOM	PROB.	

	-7.58	22	.000	
<hr/>				

The formula with the necessary substitutions appears as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left[\frac{\sum X_1^2 - \frac{(\sum X_1)^2}{N_1} + \sum X_2^2 - \frac{(\sum X_2)^2}{N_2}}{(N_1 + N_2) - 2} \right] \left[\frac{1}{N_1} + \frac{1}{N_2} \right]}}$$

$$t = \frac{4.67 - 11}{\sqrt{\frac{370 - \frac{4900}{15} + 1502 - \frac{17424}{12}}{(15 + 12) - 2} \left[\frac{1}{15} + \frac{1}{12} \right]}}$$

3.4 The t-Test for Related Measures

Another version of the t-test is the t-test for related samples. By definition, correlated or related means indicate that the subjects either acted as their own control or that the subjects are matched on one or more variables, such as sex, race, socio-economy, or age. The assumption is that the groups are equivalent. The shortcomings of matching have already been mentioned. Although using subjects as their own control minimizes these shortcomings (remind the reader of the deficiencies), a word of caution is advisable with certain designs. For example, where training methods are compared, the single group design is impossible because of the carry-over effects; also

when drug effects are compared, it is necessary to allow the effects of one medication to be eliminated before the other is applied. Another caution is that the groups also must be of equal size, that is having equal N's.

3.5 Methodology

The t-test for correlated measures is computed by the following formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{N}}{N(N-1)}}$$

where \bar{X}_1 = mean of the first method or measure

\bar{X}_2 = mean of the second method or measure

$\sum D^2$ = sum of all the squared differences between the paired scores

$(\sum D)^2$ = sum of all differences quantity squared

N = the number of paired scores

The following example will illustrate the computation of the above formula. A clinician working on improving motor skills of ten dystropic adults, designed a series of motor activities using Kozak's Motorvator. Pre-test and post-test measures were determined by the Developmental Test for Visual-Motor Integration.

Table 7
Scores on the Developmental Test
of Visual-Motor Integration

Pre-Test		Post-Test
S_1	10	15
S_2	13	15
S_3	9	16
S_4	9	11
S_5	10	13
S_6	8	11
S_7	7	15
S_8	12	16
S_9	9	10
S_{10}	11	14

STEP 1. Arrange the scores in pairs as shown above.

STEP 2. Determine the differences between the two scores and square the resulting differences.

<u>Scores</u>	<u>D</u>	<u>D²</u>	<u>Scores</u>	<u>D</u>	<u>D²</u>
10 - 15 =	-5	25	8 - 11 =	-3	9
13 - 15 =	-2	4	7 - 15 =	-8	64
9 - 16 =	-7	49	12 - 16 =	-4	16
9 - 11 =	-2	4	9 - 10 =	-1	1
10 - 13 =	-3	9	11 - 14 =	-3	9
			$D = \frac{-38}{D^2 = 190}$		

STEP 3. Sum the squared differences.

$$(25 + 4 + 49 \dots) = 190$$

STEP 4. Add algebraically the differences between the pairs.

$$(-5) + (-2) + (-7) \dots = -38$$

STEP 5. Square the value obtained in Step 4.

$$-38^2 = 1444$$

Divide the obtained value by the number of paired scores.

$$1444/10 = 144.4$$

STEP 6. Subtract Step 5 from Step 3.

$$190 - 144.4 = 45.6$$

STEP 7. Having obtained the value $\sum D^2 - (\sum D)^2/N$ in Step 6, divide the Step 6 value by $N(N - 1)$.

$$10(10 - 1) = 90$$

$$45.6/90 = .51$$

STEP 8. Take the square root of Step 7.

$$.51 = .71$$

STEP 9. Compute the means of groups \bar{X}_1 and \bar{X}_2 .

$$98/10 = 9.8 \text{ and } 136/10 = 13.6$$

STEP 10. Subtract the means \bar{X}_1 from \bar{X}_2 .

$$9.8 - 13.6 = 3.8$$

(Only absolute values are used.)

STEP 11. Divide Step 10 by Step 8.

$$3.8/.71 = 5.35$$

To determine the significance of t , again the degrees of freedom (df) must be computed. The degrees of freedom for

the t-test for related means equals $N - 1$, where N represents the number of pairs.

$$10 - 1 = 9$$

Our example is significant beyond the .001 level of confidence.

Substituting the obtained values, the formula appears as follows.

$$t = \frac{9.8 - 13.6}{\sqrt{\frac{190 - 144.4}{90}}}$$

Assignment:

Please make an appointment with the instructor to take the Unit 3 barrier.

For additional reading consult:

Linton, Marigold et al. The Practical Statistician: Simplified Handbook of Statistics. Monterey, California: Brook/Cole Publishing Co., 1975.

Spence, Janet et al. Elementary Statistics. 2nd ed. New York: Appleton-Century-Crofts, 1968.

TABLE 8

91

"Run" file entitled CORRTRUN.

1	!JOB TONY/ .DECUIR
2	!RUN SPSS.PUB.SPSS
3	RUN NAME CORRELATED T-TEST SAMPLE PROBLEM
4	VARIABLE LIST PRE, POST
5	INPUT MEDIUM DISC(CORRTDAT)
6	N OF CASES 10
7	INPUT FORMAT FIXED(F2.0,X,F2.0)
8	T-TEST PAIRS=PRE WITH POST
9	FINISH
10	!EOJ

TABLE 9

"Data" file entitled CORRTDAT.

1	10 15
2	13 15
3	09 16
4	09 11
5	10 13
6	08 11
7	07 15
8	12 16
9	09 10
10	11 14

TABLE 10
Results of CORRSTAT Analysis

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PRE		9.8000	1.814	.573
	10	13.6000	2.221	.702
POST				
2-TAIL CORR. PROB.				
.392 .263				
T DEGREES OF 2-TAIL VALUE FREEDOM PROB.				
-5.34 9 .000				

Review Unit 4

Simple One-Way Analysis of Variance

The Simple One-Way ANOVA will be treated here because of its similarity in computation and use to the t-test. The Simple One-Way ANOVA is an extension of the t-test. As with the t-test, the analysis of variance (F) is computed by dividing the difference between the groups (group means for the t-test) by an error term. The other types of ANOVA will be treated in later units.

The Simple One-Way ANOVA or the completely randomized design is appropriate with intervallic data and must meet the other assumptions associated with parametric statistical devices. It is necessary that there be only one score per subject. An equal number of subjects in each group, although desirable, is not required. It is also wise to restrict the number of groups to four or five as the results become more difficult to interpret with a larger number of groups.

Example

An experimenter interested in determining the effects of music on finger temperature in a bio-feedback experiment randomly assigned subjects to three groups corresponding to the three middle fingers of the dominant hand. Specifically, the purpose of the experiment was to determine the amount of time required to reach a target

temperature when preferred music was used as a reinforcement. The time is minutes to reach criterion.

Table 11
Finger Temperature

Group 1			Group 2			Group 3		
Finger 1 (index)			Finger 2 (middle)			Finger 3 (ring)		
S's	X	X ²	S's	X	X ²	S's	X	X ²
S ₁	4	16	S ₁₁	2	4	S ₂₁	1	1
S ₂	3	9	S ₁₂	1	1	S ₂₂	2	4
S ₃	2	4	S ₁₃	6	36	S ₂₃	1	1
S ₄	4	16	S ₁₄	7	49	S ₂₄	2	4
S ₅	5	25	S ₁₅	3	9	S ₂₅	1	1
S ₆	6	36	S ₁₆	4	16	S ₂₆	3	9
S ₇	7	49	S ₁₇	2	4	S ₂₇	2	4
S ₈	5	25	S ₁₈	3	9	S ₂₈	1	1
S ₉	4	16	S ₁₉	4	16	S ₂₉	1	1
S ₁₀	3	9	S ₂₀	1	1	S ₃₀	1	1

STEP 1. Arrange the scores as above and sum the scores from each group.

STEP 2. Square each score and sum the results.

<u>Group 1</u>	<u>Group 2</u>	<u>Group 3</u>
16	4	1
9	1	4
4	36	1
.	.	.
.	.	.
$\frac{.}{205}$	$\frac{.}{148}$	$\frac{.}{27}$

STEP 3. Add the scores in each group.

$$43 + 33 + 15 = 91$$

STEP 4. Sum the results of Step 2.

$$205 + 148 + 27 = 380$$

STEP 5. With the group scores summed in Step 3, square the value and divide by the number of scores in the experiment.

$$(91)^2 = 8281/30 = 276.03$$

This is called the Correction Factor.

STEP 6. To obtain the total sum of squares (SS_t), subtract the results of Step 4 by Step 5.

$$SS_t = 380 - 276.03 = 103.97$$

STEP 7. Square each group sum and divide by the total number in each particular group.

$$\begin{aligned} (43)^2/10 + (33)^2/10 + (15)^2/10 = \\ 184.9 + 108.8 + 22.5 = 316.3 \end{aligned}$$

STEP 8. To compute the between group sum of squares (SS_b), subtract

the Correction Factor from the results of Step 7.

$$SS_b = 316.3 - 276.03 = 40.27$$

STEP 9. To obtain the within group sum of squares, subtract the result Step 8 from the total sum of squares (Step 6).

$$SS_w = 103.97 - 40.27 = 63.7$$

STEP 10. To obtain the means squares, the total, between and within group degrees of freedom must be computed.

Degrees of freedom total (df_T) = total scores minus 1

$$df_T = 30 - 1 = 29$$

Degrees of freedom between the groups (df_b) = the number of groups minus 1.

$$df_b = 3 - 1 = 2$$

Degrees of freedom within the groups (df) = the total number of scores minus the number of groups.

$$df_w = 30 - 3 = 27$$

STEP 11. The mean square values are computed by dividing the sum of squares for total, within and between by its corresponding degrees of freedom term.

$$MS_{total} = 103.97/27 = 3.85$$

$$MS_{within} = 63.7/27 = 2.36$$

$$MS_{between} = 40.27/2 = 20.14$$

STEP 12. To obtain F, divide the $MS_{between}$ by the MS_{within} .

$$F = 20.14/2.36 = 8.53$$

STEP 13. The summary table is the final necessary step.

Table 12

Summary

Sources	SS	df	MS	F
Total	103.97	29	3.85	
Between	40.27	2	20.14	8.53
Within	63.7	27	2.36	

The degrees of freedom used to determine the probability of F are the within and between group values.

Assignment:

Compute the unit example manually and on the computer terminal. Submit your findings, including the computer print-out, to the instructor.

Please make an appointment with the instructor to take the Review Unit 4 Barrier.

For additional reading consult:

Linton, Marigold et al. The Practical Statistician: Simplified Handbook of Statistics. Monterey, California: Brook/Cole Publishing Co., 1975.

Spence, Janet et al. Elementary Statistics. 2nd ed. New York: Appleton-Century-Crofts, 1968.

TABLE 13

"Run" file entitled UNITIRUN.

1	!JOB TONY/	.DECUIR
2	!RUN SPSS.PUB.SPSS	
3	RUN NAME	ONE-WAY ANOVA SAMPLE PROBLEM
4	VARIABLE LIST	DV,IV
5	INPUT MEDIUM	DISC(UNIT1DAT)
6	N OF CASES	30
7	INPUT FORMAT	FIXED(F1.0,X,F1.0)
8	ANOVA	DV BY IV(1,3)
9	STATISTICS	1,3
10	ONEWAY	DV BY IV(1,3)/
11		RANGES=TUKEY(.05)
12	STATISTICS	1,3
13	FINISH	
14	!EOJ	

TABLE 14

"Data" file entitled UNIT1DAT.

1	4	1
2	3	1
3	2	1
4	4	1
5	5	1
6	6	1
7	7	1
8	5	1
9	4	1
10	3	1
11	2	2
12	1	2
13	6	2
14	7	2
15	3	2
16	4	2
17	2	2
18	3	2
19	4	2
20	1	2
21	1	3
22	2	3
23	1	3
24	2	3
25	1	3
26	3	3
27	2	3
28	1	3
29	1	3
30	1	3

Note that this is a numbered file with the numbers appearing in the first column. Raw data appears in the second column and the groups are coded (1, 2, 3) in the third column.

Unit 1

Analyses of Variance: Factorial Designs

The factorial design is a completely randomized design containing two or more independent variables (factors) and permits one group of variables to be manipulated in conjunction with another group.

Kerlinger (1973) defines factorial analysis of variance as a statistical device which assesses the effects on a single dependent variable of several independent variables (factors) and their "interaction effects."²¹²

Since there are several types of factorial designs, they are differentiated by the number of factors or independent variables involved. For example, the design involving two factors is commonly referred to as a two-way analysis of variance, two-factor analysis of variance, or sometimes as a simple factorial ANOVA. The subgroups of each of the independent variables are referred to as levels.

Unlike the simple analysis of variance involving only one factor, the simple factorial design involves three research questions, corresponding to the two main effects and the one interaction. One main effect question represents the differences between the means of the rows, the other main effect question the difference between the means of the columns. The interaction effect, however, represents the

²¹²

Fred Kerlinger, Foundations of Behavioral Research, 2nd ed. (New York: Holt, Rinehart and Winston, Inc., 1973), p. 245.

impact of the two main effect variables acting in combination on the dependent variable. Put another way, the three effects represent differences in the means of the rows, means of the columns, and the individual cell means.

Remember the following in the computation of the factorial

ANOVA:

1. One score per subject, if more than one score is taken these scores must be combined
 - a. combining data here is permitted because we are dealing with intervallic data
2. Optimal sample size is 10-15 subjects per group, with an equal number of subjects in each group
3. In the 2×2 and 2×3 designs it is preferable to keep the number of groups per factor 2 or 3.

Example

A music therapist employed in a special education classroom investigated the effects of sound intensities on the visual recognition skills of learning disabled children whose primary disability was visual. The researcher selected continuous aural intensities of 60 and 100 db. The visual task was a standardized pattern recognition test. The data are as follows.

Table 15

Intensity

	60 db	\bar{X}^2		100 db	\bar{X}^2
s_1	5	25	s_6	3	9
s_2	6	36	s_7	7	49
s_3	7	49	s_8	5	25
s_4	8	64	s_9	8	64
s_5	$\frac{4}{30}$	$\frac{16}{190}$	s_{10}	$\frac{6}{29}$	$\frac{36}{183}$
s_{11}	6	36	s_{16}	8	64
s_{12}	5	25	s_{17}	4	16
s_{13}	7	49	s_{18}	5	25
s_{14}	5	25	s_{19}	3	9
s_{15}	$\frac{3}{26}$	$\frac{9}{144}$	s_{20}	$\frac{4}{24}$	$\frac{16}{130}$

STEP 1. Arrange the scores as above, and sum the scores in each group.

$$(30 + 26 + 29 + 24) = 109$$

STEP 2. Square each score and sum the results.

$$(5^2 + 6^2 + 7^2 + 4^2 \dots) = 647$$

STEP 3. Having summed the scores in each group (See Step 1), square the total, and divide by the total number of scores in the

study.

$$\frac{109^2}{20} = 594.05$$

This term is referred to as the Correction Factor.

STEP 4. To find the total sums of squares (SS_t), subtract the Correction Factor from the sum of all the squared scores (Step 2).

$$SS_t = 647 - 594.05 = 52.95$$

STEP 5. To find out the effect of the first factor (here, 60 db versus 100 db) add the sums of the two sound intensity groups, ignoring the visual task factor.

$$30 + 26 = 56 \quad (60 \text{ db})$$

$$29 + 24 = 53 \quad (100 \text{ db})$$

Next, square each of the totals and divide the result by the number of scores in the overall groups, here 10.

$$56^2/10 + 53^2/10 = 594.5$$

To find out the sum of square for the first factor (here, sound intensity), subtract the Correction Factor from the above quantity.

$$SS \text{ intensity} = 594.5 - 594.05 = .45$$

STEP 6. To obtain the effects of the second factor (here, visual recognition) add the sums of the two visual recognition factors, this time ignoring sound intensity.

$$30 + 29 = 59 \quad (\text{Visual A})$$

$$26 + 24 = 30 \quad (\text{Visual B})$$

Again, square each of the totals and divide the result by the number of scores in the overall groups, here 10.

$$59^2/10 + 30^2/10 = 598.1$$

To determine the sum of squares for the second factor (here, visual recognition), subtract the Correction Factor from the above quantity.

$$SS \text{ visual} = 598.1 - 594.05 = 4.05$$

STEP 7. To compute the interaction effect, square the sums of each of the individual groups or cells (Step 1) and divide the square of each cell by the number of scores in the cell.

$$30^2/5 + 26^2/5 + 29^2/5 + 24^2/5 = 598.6$$

Now, determine the sum of squares for the interaction by subtracting the Correction Factor, SS intensity and SS visual.

$$SS \text{ visual} \times \text{sound intensity} = 598.6 - 594.05 - 4.05 - .45 = .05$$

STEP 8. To compute the error factor sum of squares (SS error), subtract SS intensity (Step 5), SS visual (Step 6), and SS intensity x visual (Step 7) from SS total (Step 4).

$$SS \text{ error} = 52.95 - .45 - 4.05 - .05 = 48.4$$

STEP 9. To compute the Means Squares, the total degrees of freedom, the degree for SS intensity, SS visual and SS intensity x visual must first be obtained.

df for SS_t = total number of scores minus 1

In our example $20 - 1 = 19$

df intensity = number of intensity conditions - 1

$$df_I = 2 - 1 = 1$$

df visual = number of visual conditions - 1

$$df_v = 2 - 1 = 1$$

df intensity x visual = df intensity x df visual =

$$1 \times 1 = 1$$

df error = $df_t - df \text{ intensity} - df \text{ visual} - df \text{ intensity} \times \text{visual}$ =

$$19 - 1 - 1 - 1 = 16$$

STEP 10. The mean square values are computed by dividing the SS by its corresponding degrees of freedom.

MS total (not required)

$$MS \text{ intensity} = SS \text{ intensity} / 1 = .45 / 1 = .45$$

$$MS \text{ visual} = SS \text{ visual} / 1 = 4.05 = 4.05$$

$$MS \text{ intensity} \times \text{visual} = SS \text{ intensity} \times \text{visual} / 1 = .05 / 1 = .05$$

$$MS \text{ error} = SS \text{ error} / 1 = 48.4 / 16 = 3.025$$

STEP 11. To compute the F ratios, divide

$$MS \text{ intensity} / MS \text{ error} = .45 / 3.025 = .149$$

$$MS \text{ visual} / MS \text{ error} = 4.05 / 3.025 = 1.34$$

$$MS \text{ intensity} \times \text{visual} / MS \text{ error} = .05 / 3.025 = .0165$$

STEP 12. A necessary and required part of the analysis of variance is the Summary Table. It appears as follows.

Summary

<u>Sources</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>p</u>
Total	32.95	19	-	-	-
Intensity	.45	1	.45	.15	N.S.
Visual	4.05	1	4.05	1.34	N.S.
Intensity x Visual	.05	1	.05	.02	N.S.
Error	48.4	16	3.03	-	-

Table of F ratios indicates that none of the F ratios is significant. We conclude, therefore, that the two sound intensity levels did not effect the performance of the visually impaired learning disabled students.

"Run" file entitled TREATRUN and the "data" file entitled TREATDAT.

```

1      !JOB TONY/ .DECUIR
2      !RUN SPSS.PUB.SPSS
3      RUN NAME      TREATMENT (2-WAY FACTORIAL) ANOVA
4      VARIABLE LIST DV,INTENS,TASK
5      INPUT MEDIUM DISC(TREATDAT)
6      N OF CASES    20
7      INPUT FORMAT  FIXED(3F1.0)
8      VALUE LABEL   INTENS (1)LOW (2)HIGH/
9                   TASK (1)A (2)B
10     ANOVA          DV BY INTENS(1,2) TASK(1,2)
11     STATISTICS     1,3
12     FINISH
13     !EOJ

```

```

1      511
2      611
3      711
4      811
5      411
6      612
7      512
8      712
9      512
10     312
11     321
12     721
13     521
14     821
15     621
16     822
17     422
18     522
19     322
20     422

```

TABLE 17
ANOVA Summary Table

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	4.500	2	2.250	.744	.491
INTENS	.450	1	.450	.149	.705
TASK	4.050	1	4.050	1.339	.264
2-WAY INTERACTIONS	.050	1	.050	.017	.899
INTENS TASK	.050	1	.050	.017	.899
EXPLAINED	4.550	3	1.517	.501	.687
RESIDUAL	48.400	16	3.025		
TOTAL	52.950	19	2.787		

Note that under Sources of Variation the titles Main Effect, 2-Way interaction, or Explained are not found in most summary tables.

Unit 2

Analysis of Variance: Treatment Designs

The Treatment Designs are a modification of the Two-Factor design. The computation is straightforward. The SS_{total} , SS_{between} , and SS_{within} are calculated in the same fashion as the two-way analysis of variance. Compare the computational steps of the two-way with the treatment-by-levels design. Treatment-by-levels is also referred to as "nested" design in some sources. The treatment design is used most often in the comparison of treatment methods (teaching, therapeutic) with samples that differ initially (schools, hospitals, etc.).

Remember the following in the computation of the Treatment Design:

1. As in the factorial design, there should only be one score for each subject. Since the data are intervallic, it is permissible to combine scores.
2. 10 to 15 subjects in each group is optimal and equal numbers in each group are required.
3. In the 2×2 as well as in the 2×3 , it is preferable to keep the number of groups for each factor to 4 or 5.

Example

An investigator compared the effects of a traditional reality orientation program and a music-based reality orientation program

on geriatric patients from three institutions located in three different states. A popular standardized test was used for the dependent variable. The data appear as follows:

<u>Napa State Hospital</u>	
<u>Music-RO</u>	<u>Traditional-RO</u>
S ₁ 20	S ₄ 19
S ₂ 18	S ₅ 20
S ₃ 14	S ₆ 20
<u>Georgia Mental Health</u>	
S ₇ 14	S ₁₀ 12
S ₈ 18	S ₁₁ 12
S ₉ 14	S ₁₂ 9
<u>Topeka State Hospital</u>	
S ₁₃ 13	S ₁₆ 9
S ₁₄ 16	S ₁₇ 4
S ₁₅ 13	S ₁₈ 4

STEP 1. After the data collection has been completed, array the data as follows.

<u>Napa State Hospital</u>	
<u>Music-RO</u>	<u>Traditional-RO</u>
S ₁ 20 400	S ₄ 19 361
S ₂ 18 324	S ₅ 20 400
S ₃ 14 <u>196</u>	S ₆ 20 <u>400</u>
920	1161

Georgia Mental Health

S_7 14 196
 S_8 18 324
 S_9 14 196
 716

S_{10} 12 144
 S_{11} 12 144
 S_{12} 9 81
 369

Topeka State Hospital

S_{13} 13 169
 S_{14} 16 256
 S_{15} 13 169
 594

S_{16} 9 81
 S_{17} 4 16
 S_{18} 4 16
 113

STEP 2. Total the scores in each group.

52	59
46	33
42	17

STEP 3. Take the summed squared for each group from Step 1 and sum the results.

$$920 + 1161 + 716 + 369 + 594 + 113 = 3873$$

STEP 4. To compute the grand sum, total the scores in the experiment in Step 2.

$$52 + 46 + 42 + 59 + 33 + 17 = 249$$

Squaring this total and dividing by the number of subjects in the experiment gives the Correction Factor.

$$249^2/18 = 3444.5$$

STEP 5. To compute the total sum of squares (SS_t) subtract the Correction Factor from the sum of the squared scores in Step 3.

$$SS_t = 3873 - 3444.5 = 428.5$$

STEP 6. To compute the sum of squares for geographic region, sum the total of the three areas (or levels).

$$52 + 59 = 111 \quad \text{Napa State Hospital}$$

$$46 + 33 = 79 \quad \text{Georgia Mental Health}$$

$$42 + 17 = 59 \quad \text{Topeka State Hospital}$$

Next, square each of the totals and divide by the number of scores which made up the total.

$$111^2/6 + 79^2/6 + 59^2/6 = 3673.84$$

Then subtract the Correction Factor.

$$SS \text{ geography} = 3673.84 - 3444.5 = 229.34$$

STEP 7. To compute the effects due to the two treatment methods (music reality orientation versus traditional reality orientation), sum the treatment effects ignoring the geographic location and divide by the number of subjects in each group.

$$149^2/9 + 109^2/9 = 3497.89$$

To compute the effects due to treatment, subtract the Correction Factor from the above figure.

$$SS \text{ treatment} = 3497.89 - 3444.5 = 53.39$$

STEP 8. To compute the effects due to the interaction of treatment and geography, square the sum of each of the cells as follows:

$$52^2/3 + 59^2/3 + 46^2/3 + 33^2/3 + 42^2/3 + 17^2/3 = 3814.33$$

Then, subtract the Correction Factor, SS geography levels (Step 6) and SS treatment (Step 7).

$$\text{SS geography} \times \text{treatment} = 3814.33 - 3444.5 - 229.34 - 53.39 = 87.1$$

STEP 9. To compute the error term (SS error), subtract from the total sum of squares, SS geography (Step 6), SS treatment (Step 7), and SS geography x treatment (Step 8).

$$\text{SS error} = 428.5 - 229.34 - 53.39 - 87.1 = 58.67$$

STEP 10. Next, compute the degree of freedom terms.

$$\text{df for SS}_t = \text{total measures} - 1 = 17$$

$$\text{df for SS geography} = 3 - 1 = 2$$

$$\text{df for SS treatments} = 2 - 1 = 1$$

$$\text{df for SS geography} \times \text{treatment} = 2 \times 1 = 2$$

$$\text{df for SS error} = \text{df total} - \text{df geography} - \text{df treatment} -$$

$$\text{df geography} \times \text{treatment} = 17 - 2 - 1 - 2 = 12$$

STEP 11. To compute the mean square terms, divide the sum square term by the appropriate df terms.

$$\text{MS total} - \text{not necessary}$$

$$\text{MS geography} = 229.34/2 = 114.67$$

,

$$MS \text{ treatment} = 53.39/1 = 53.39$$

$$MS \text{ geography} \times \text{treatment} = 87.1/2 = 43.55$$

$$MS \text{ error} = 58.67/12 = 4.89$$

STEP 12. To compute the F Ratios

$$F \text{ geography} = MS \text{ error} = 114.67/4.89 = 23.44$$

$$F \text{ geography} \times \text{treatment} = MS \text{ geography} \times \text{treatment} / MS \text{ error} = 43.55/4.89 = 8.91$$

Summary Table for Treatment Designs

Source	SS	df	MS	F	P
Total	428.5	17	-	-	-
Level (geography)	229.34	2	114.67	23.44	2.001
Treatment	53.59	1	53.39	10.92	2.01
Level x treatment	87.1	2	43.55	8.91	2.005
Error	58.67	12	4.89	-	-

From the above results, we conclude that there is a significant ($p < .001$) difference in scores between the three facilities (NAPA State Hospital, Georgia Mental Health, and Topeka State Hospital). We note further a significant difference between the treatment groups (music reality orientation and traditional reality orientation). Finally, a significant interaction effect is observed between the different facilities and the two treatment effects. As a general rule,

whenever interactions are significant the interpretation concentrates on the interaction effects. In this example, therefore, programs had different effects depending on the institution in which it was used. Further post hoc analyses would reveal the exact nature of these significances.

"Run" file entitled LEVELRUN; data file entitled LEVELDAT.

```

1  !JOB TONY/ .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      TREATMENT BY LEVELS (2 BY 3 FACTORIAL)
4  VARIABLE LIST RO.GEOG.THERAPY
5  INPUT MEDIUM DISC(LEVELDAT)
6  N OF CASES    18
7  INPUT FORMAT  FIXED(F2.0,2F1.0)
8  VALUE LABEL   GEOG (1)HAPA (2)GEORGIA (3)TOPEKA/
9                THERAPY (1)MUSICRO (2)TRADITRO
10 ANOVA          RO BY GEOG(1,3) THERAPY(1,2)
11 STATISTICS     1,3
12 FINISH
13 !EQJ

```

1	2011
2	1811
3	1411
4	1912
5	2012
6	2012
7	1421
8	1821
9	1421
10	1222
11	1222
12	0922
13	1331
14	1631
15	1331
16	0932
17	0432
18	0432

Note the eighteen numbered cases designated by the first column. The four digit second column contains the raw data in in the first two digits and the group codes in the second two digits.

ANOVA Summary table

ANALYSIS OF VARIANCE				
RO				
BY GEOG				
THERAPY				
SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F
MAIN EFFECTS	282.722	3	94.241	19.277
GEOG	229.333	2	114.667	23.455
THERAPY	53.389	1	53.389	10.920
2-WAY INTERACTIONS	87.111	2	43.556	8.909
GEOG THERAPY	87.111	2	43.556	8.909
EXPLAINED	369.833	5	73.967	15.130
RESIDUAL	58.667	12	4.889	
TOTAL	428.500	17	25.206	

Note the differences in the summary table from the book versions. Under the Sources of Variation Main Effects, 2-way, and Explained are usually excluded in the book versions.

Unit 3

Analysis of Variance: Mixed Designs

The term "mixed design" has several different meanings to statisticians. The most common use of this term is to designate a design which is a mixture of the repeated measures design and the independent groups design. In this mixed effects ANOVA, there must be at least two independent variables, at least one of which represents different groups of subjects and at least one of which involves repeated measurements on the same subjects. These designs have been variously designated in the literature as the split plot designs (Kirk, 1968),²¹³ Lindquist type I design, and multifactor experiments having repeated measures on some elements.

An example should help clarify this design. A music therapist attempting to determine the most efficient therapeutic method for extinguishing anti-social behaviors in adolescent mental retardates might use the following approach. Forty-five adolescents could be randomly assigned to three groups with three different therapeutic approaches. The subjects could be observed four times throughout the course of treatment - beginning, middle, end, and two weeks after all treatment has stopped. In this experiment there are two factors:

²¹³

Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences (Belmont, California: Brooks/Cole Publishing Co., 1968).

therapeutic methods and time of observation. For the repeated measure in the above example, subjects are measured at various times during the course of the study. The student should note that the levels of a particular factor are not separate factors. That is, three therapeutic methods are still only one factor - therapeutic methods - with three levels. There are three research questions answered by this design, similar to the 2×2 ANOVA. The questions of concern to the researcher are (1) is there a significant difference due to the main effects of variable A (therapeutic method), (2) is there a significant difference in the scores taken at the various time of administration, and (3) is there a significant difference due to the interaction of therapeutic method over time of administration.

In the simplest mixed effects ANOVA, there are two independent variables, each with two levels. The example presented above was this simplest form with three levels of each variable. It also would be possible to expand this design by the inclusion of a third independent variable so that there would be two between and one within variable, or so that there would be one between variable and two within variables. These variations would each be three-way mixed effects ANOVA's, because there are three independent variables, but they would look quite different and would be analyzed differently.

The Lindquist Type III ANOVA and the three-way analysis of variance are similar to the relationship between the Lindquist Type I ANOVA and the 2×2 ANOVA. For example, a music therapist might study the

effects of bell choir, chorus, and dance group on aural acuity of trainable and educable mental retardates. The therapist might assign five TMR and five EMR clients to each of the performing groups with an aural acuity test administered at four times throughout the course of the treatment. According to the split-plot formula previously described, this Lindquist Type III ANOVA example might appear as 32.4 ANOVA, where the first factor is represented by three levels, the second factor two levels, and four observations constitute the repeated measures factor. The number of F ratios appearing in the summary table is seven: there are three main effect questions, three first order interactions, and one second order interaction. The sample problem would appear as follows in tabular form.

<u>Source</u>	<u>df</u>	<u>SS</u>	<u>MS</u>	<u>F</u>
Between-subject	29			
Therapeutic Group (TG)	2			*
Functioning Level (FL)	1			*
TG x FL	2			*
Between Subject Error	24			
Within-subject	90			
Exam Administration (EA)	3			*
EA x TG	6			*
EA x FL	3			*
EA x FL x TG	6			*
Within-subject error	72			
Total	119			

Please consider the following hints in computing mixed designs analyses of variance. There should be (1) an equal number of subjects in each group, (2) four or five groups per variable is normally a maximum, and (3) there should be one score in each cell per observation.

The following is an example of the Lindquist Type III design.

Example

A music therapist employed in a stress unit of a general hospital was interested in studying the effects of a music bio-feedback paradigm. The 20 subjects were divided into two general body-types: ectomorphs and mesomorphs, and each group was assigned to two different musical reinforcements: preferred and non-preferred music. The subjects were given four trials to reduce the H^+ ion concentration in the stomach. The following data were realized.

Table 20
Analysis of Variance

		Trials				Σ
S's		1	2	3	4	
	S_1	14	10	10	8	42
	S_2	16	9	10	5	40
B_1	S_3	18	16	12	7	53
(Ectomorph)	S_4	17	14	11	8	50
	S_5	$\frac{22}{87}$	$\frac{19}{68}$	$\frac{17}{60}$	$\frac{10}{38}$	$\frac{68}{253}$

Table 20--Continued

	S's	1	2	3	4	Σ
A ₁ (preferred music)	S ₆	18	19	17	15	69
	S ₇	25	24	20	16	85
B ₂	S ₈	37	35	32	24	128
(Mesomorph)	S ₉	21	18	15	14	68
	S ₁₀	<u>29</u> 139	<u>29</u> 125	<u>28</u> 112	<u>26</u> 95	<u>112</u> 462
	S ₁₁	17	15	10	7	49
	S ₁₂	24	12	9	9	54
B ₁	S ₁₃	28	20	14	12	74
(Ectomorph)	S ₁₄	30	22	16	12	80
	S ₁₅	<u>22</u> 121	<u>16</u> 85	<u>9</u> 58	<u>4</u> 44	<u>51</u> 308
A ₂ (non-preferred music)	S ₁₆	42	34	30	22	128
	S ₁₇	29	28	26	22	105
B ₂	S ₁₈	26	25	20	16	87
(Mesomorph)	S ₁₉	30	30	25	14	99
	S ₂₀	<u>26</u> 153	<u>27</u> 144	<u>20</u> 121	<u>12</u> 86	<u>85</u> 504
Grand Totals: (Trials)		491	421	351	263	1527

STEP 1. Array the data as shown in the above example.

STEP 2. Sum the scores in each of the cells.

14	10	10	8
16	9	10	5
.	.	.	.
.	.	.	.
<u>87</u>	<u>68</u>	<u>60</u>	<u>38</u>

18	19	17	15
25	24	20	16
37	35	32	24
.	.	.	.
.	.	.	.
<u>130</u>	<u>125</u>	<u>112</u>	<u>95</u>

17	15	10	7
24	12	9	9
28	20	14	12
.	.	.	.
.	.	.	.
<u>121</u>	<u>85</u>	<u>58</u>	<u>44</u>

42	34	30	22
29	28	26	22
26	25	20	16
.	.	.	.
.	.	.	.
<u>153</u>	<u>144</u>	<u>121</u>	<u>86</u>

STEP 3. Add the sums of the cells by adding the individual trials.

$$\text{Group 1} = 87 \quad 68 \quad 60 \quad 38 = 253$$

$$\text{Group 2} = 130 \quad 125 \quad 112 \quad 95 = 462$$

$$\text{Group 3} = 121 \quad 85 \quad 58 \quad 44 = 308$$

$$\text{Group 4} = 153 \quad 144 \quad 121 \quad 86 = 504$$

STEP 4. Sum the scores for the subjects across trials.

$$(42 + 40 + 53 \dots 85) = 1527$$

STEP 5. Square each score in the entire table.

$$(142 + 10^2 + 10^2 + \dots 12^2) = 34483.01$$

STEP 6. Total the scores of the four groups.

$$(253 + 462 + 308 + 504) = 1527$$

STEP 7. Square the result of Step 6 and divide the number of scores used in the Table (subjects x trials).

$$1527^2/80 = 29146.61$$

This is the Correction Factor

STEP 8. Compute SS_t by subtracting the Correction Factor (Step 7) from the grand total of Step 5.

$$SS_t = 34483.01 - 29146.61 = 5336.4$$

STEP 9. Compute the between subjects sum of squares (SS_b) by adding each subject's scores across the four trials, squaring the value and dividing by the number of trials.

$$42^2/4 + 40^2/4 \dots 85^2/4 = 32658.21$$

Next subtract the Correction Factor from the above value.

$$32658.21 - 29146.61 = 3511.6$$

SS between subjects

STEP 10a. Compute the effects of the condition (SS condition).

Square the scores of the four conditions and divide by the number of scores in each condition.

$$(253)^2/20 + (426)^2/20 + (308)^2/20 + (504)^2/20 = 26976.61$$

Next, subtract the Correction Factor.

$$SS = 31316.65 - 29146.61 = 2170.04$$

This between conditions figure provides an arithmetic check of all between-subject factors.

STEP 10b. Compute the between-subject sum of squares for the first variable (music) by adding together the four music conditions (preferred versus non-preferred) disregarding somatype.

$$A_1 B_1 + A_1 B_2 = 253 + 462 = 712$$

$$A_2 B_2 + A_2 B_1 = 308 + 504 = 812$$

Square the results of the above computation, divided by the number of scores in each condition ($A_1 B_1 + A_1 B_2$), and subtract the Correction Factor.

$$SS_A (712)^2/40 + (812)^2/40 - 29146.61 = 117.6$$

STEP 11. Compute the sum of square for the second variable in like fashion except this time add the scores of the groups according to the second variable (somatype).

$$A_1 B_1 + A_2 B_1 = 253 + 308 = 561$$

$$A_1 B_2 + A_2 B_2 = 462 + 504 = 966$$

Square these results, divide by the number of scores in

groups, and subtract the Correction Factor.

$$SS_B = (561)^2/40 + (966)^2/40 - 29146.61 = 2050.32$$

STEP 12. Compute the sum of squares for the interaction of variable A by variable B (music x somatype) by adding group 1 + 4 and S + 3.

$$A_1 B_1 + A_2 B_2 = 757$$

$$A_1 B_2 + A_2 B_1 = 770$$

Square the above sums, divide by the number of scores in the combined groups, and subtract the Correction Factor.

$$SS_{A \times B} = (757)^2/40 + (770)^2/40 - 29146.61 = 2.1$$

STEP 13. Compute the error term for the sum of squares for the between-subjects variables by subtracting the $SS_{\text{variable A}}$ (Step 10), $SS_{\text{variable B}}$ (Step 11) and $SS_{A \times B}$ (Step 12) from the SS between subjects (Step 9).

$$SS \text{ error} = SS \text{ between-subject} - SS \text{ variable A} - SS \text{ variable B} - SS \text{ variable A} \times B$$

$$SS \text{ error} = 3511.6 - 117.6 - 2050.32 - 2.1 = 1341.58$$

STEP 14. Compute the within-subject sum of squares (recall that within-subjects is synonymous with repeated measures) by subtracting the SS between-subject (Step 9) from the SS_T (Step 8).

$$SS_W = SS_T - SS \text{ between subjects}$$

$$SS_W = 5336.4 - 3511.6 = 1824.8$$

STEP 15. Compute the sum of squares for trials (SS trials) by adding

the scores of the trials (here, the four columns), squaring the results and dividing each by the number of scores in the respective trials. Add the results.

$$(491)^2/20 + (422)^2/20 + (351)^2/20 + (263)^2/20 = 30576.75$$

Next subtract the Correction Factor.

$$SS \text{ trials} = 30576.75 - 29146.61 = 1430.14$$

STEP 16. Compute the sum of squares trials by conditions (SS trials x conditions) interaction by adding the scores for the two A groups (music) ignoring the second variable (See Step 2).

	Trial 1	Trial 2	Trial 3	Trial 4
A ₁	217	193	172	133
A ₂	274	229	179	130

Next, square each of the totals (here 8), and divide by the number of scores in the trials (here 10). Add the results.

$$(217)^2/10 + (193)^2/10 + (172)^2/10 + (133)^2/10 + (274)^2/10 + (229)^2/10 + (179)^2/10 + (130)^2/10 = 30806.9$$

Next, subtract the Correction Factor, SS_A (Step 10) and SS trials (Step 15).

$$SS \text{ trials x A's} = 30806.9 - 29146.61 - 117.6 - 1430.14 = 112.6$$

STEP 17. Compute the sum of squares for trials versus the second variable (somatype). Tabulate the second variable across trials ignoring the first variable (music).

	Trial 1	Trial 2	Trial 3	Trial 4
B ₁	208	153	118	82
B ₂	283	269	233	181

Again, square each of the totals and divide by the number of scores in the trial. Add the results.

$$(208)^2/10 + (153)^2/10 + (118)^2/10 + (82)^2/10 + (283)^2/10 + (269)^2/10 + (233)^2/10 + (181)^2/10 = 32682.1$$

Next, subtract the Correction Factor, SS somatype (Step 11) and SS trials (Step 15).

$$32682.1 - 29146.31 = 3535.5$$

$$SS_{\text{trials}} \times B = 32682.1 - 29146.61 - 2050.32 - 1430.14 = 55.1$$

STEP 18. Compute the second order interaction sum of squares trials x music x somatype ($SS_T \times A \times B$). Sum the scores for each of the trials for each of the experimental groups, square each score and divide by the number of scores in each trial.

$$(87)^2/5 + (68)^2/5 + (60)^2/5 + (38)^2/5 + (130)^2/5 + (125)^2/5 + (112)^2/5 + (95)^2/5 + (121)^2/5 + (85)^2/5 + (58)^2/5 + (44)^2/5 + (153)^2/5 + (144)^2/5 + (121)^2/5 + (86)^2/5 = 32935.81$$

From the above figure subtract the Correction Factor, SS_A

SS_B (Step 11), $SS_{A \times B}$ (Step 12), SS_{Trials} (Step 15), $SS_{\text{Trial} \times A}$ (Step 16), and $SS_{\text{Trial} \times B}$ (Step 17).

$$32935.81 - 29146.61 - 117.6 - 2050.32 - 2.1 - 1430.14 - 112.6 = 55.1$$

$SS_{\text{Trial} \times A \times B} = 21.3$ (This figure differs slightly from the computer figure of 21.4.)

STEP 19. Compute the within subject error term by:

$$\begin{aligned} \text{Error}_W &= SS_W \text{ (Step 14)} - SS_{\text{Trial} \times A} \text{ (Step 15)} - SS_{\text{Trial} \times B} \text{ (Step 16)} \\ &\quad - SS_{\text{Trial} \times A \times B} \text{ (Step 17)} - SS_{\text{Trial} \times A \times B} \text{ (Step 18)} \end{aligned}$$

$$\text{Error}_W = 1824.8 - 1430.14 - 112.6 - 55.1 - 21.3 = 205.6$$

STEP 20. The sums of squares calculations are complete.

$$SS_T = 5336.4 \text{ (Step 8)}$$

$$SS_{\text{between subjects}} = 3511.6 \text{ (Step 9)}$$

$$SS_A \text{ variable} = 117.6 \text{ (Step 10b)}$$

$$SS_B \text{ variable} = 2050.32 \text{ (Step 11)}$$

$$SS_{A \times B} = 2.1 \text{ (Step 12)}$$

$$SS_{\text{error between}} = 1341.58 \text{ (Step 13)}$$

$$SS_W = 1824.8 \text{ (Step 14)}$$

$$SS_{\text{Trial} \times A} = 1430.14 \text{ (Step 15)}$$

$$SS_{\text{Trial} \times B} = 112.6 \text{ (Step 16)}$$

$$SS_{\text{Trial} \times A \times B} = 55.1 \text{ (Step 17)}$$

$$SS_{\text{Trial} \times A \times B} = 21.3 \text{ (Step 18)}$$

$$SS_{\text{error within}} = 205.6 \text{ (Step 19)}$$

STEP 21. Before computing the mean squares it is necessary to compute the degrees of freedom (df).

$$df_T = \text{total number of scores} - 1 = 80 - 1 = 79$$

$$df_{\text{between}} = \text{total number of subjects} - 1 = 20 - 1 = 19$$

$$df_A = \text{number of A groups} - 1 = 2 - 1 = 1$$

$$df_B = \text{number of B groups} - 1 = 2 - 1 = 1$$

$$df_{A \times B} = df_A \times df_B = 1 \times 1 = 1$$

$$df_{\text{error}} = df_{\text{between}} - df_A - df_B - df_{A \times B} = 19 - 1 - 1 - 1 = 16$$

$$df_w = df_T - df_{\text{between}} = 79 - 19 = 60$$

$$df_{\text{Trials}} = \text{number of trials per subject} - 1 = 4 - 1 = 3$$

$$df_{\text{Trials} \times A} = df_{\text{Trials}} \times df_A = 3 \times 1 = 3$$

$$df_{\text{Trials} \times B} = df_{\text{Trials}} \times df_B = 3 \times 1 = 3$$

$$df_{\text{Trials} \times A \times B} = df_{\text{Trials}} \times df_A \times df_B = 3$$

$$\begin{aligned} df_{\text{error w}} &= df_w - df_{\text{Trials}} - df_{\text{Trials} \times A} - df_{\text{Trials} \times B} \\ &= df_{\text{Trials} \times A \times B} \\ &= 60 - 3 - 3 - 3 = 51 \\ &= 48 \end{aligned}$$

STEP 22. Compute the means squares by dividing the sum of squares (SS) by the appropriate degrees of freedom (df).

MS_t - not required

MS_{between} - not required

$$MS_A = SS_A / df_A = 117.6 / 1 = 117.6$$

$$MS_B = SS_B / df_B = 2050.3 / 1 = 2050.3$$

$$MS_{A \times B} = SS_{A \times B} / df_{A \times B} = 2.1 / 1 = 2.1$$

$$MS_{\text{error b}} = SS_{\text{error b}} / df_{\text{error b}} = 1341 / 16 = 83.8$$

$$MS_w = SS_w / df_w = \text{not required}$$

$$MS_{\text{Trials}} = SS_{\text{Trials}} / df_{\text{Trials}} = 1430.1 / 3 = 476.7$$

$$MS_{\text{Trials} \times A} = SS_{\text{Trials} \times A} / df_{\text{Trials} \times A} = 112.6 / 3 = 37.5$$

$$MS_{\text{Trials} \times B} = SS_{\text{Trials} \times B} / df_{\text{Trials} \times B} = 55.1/3 = 18.4$$

$$MS_{\text{Trials} \times A \times B} = SS_{\text{Trials} \times A \times B} / df_{\text{Trials} \times A \times B} \\ = 21.7/3 = 7.1$$

$$MS_{\text{error} - w} = SS_{\text{error} - w} / df_{\text{error} - w} = 205.6/48 = 4.3$$

STEP 23. Determine the F-ratios by dividing the MS of the variables (A, B, and trials) by the appropriate mean square error term.

$$F_A \text{ Variable A} / MS_{\text{error} - b} = 117.6/83.8 = 1.40$$

$$F_B \text{ Variable B} / MS_{\text{error}/b} = 2050.3/83.8 = 24.47 **$$

$$F_{AB} \text{ Variable A} \times B = 2.1/83.8 = 1.00$$

$$F_{\text{Trials}} \text{ Variable Trials} / MS_{\text{error}_w} = 476.7/4.3 = 110.86 **$$

$$F_{\text{Trials} \times A} = \text{Variable Trials} \times A / MS_{\text{error}_w} = 37.5/4 \\ = 8.72 **$$

$$F_{\text{Trials} \times a \times b} = \text{Variable Trials} \times A \times B / MS_{\text{error}_w} \\ = 7.1/4.3 = 1.65$$

STEP 24. A necessary part of the analyses of variance is the tabular reporting of the results.

Table 21

Sources	SS	df	MS	F
Total	5336.4	79	-	-
Between Subjects	3511.6	19	-	-
Variable A	117.6	1	117.6	1.40
Variable B	2050.3	1	2050.3	24.47
Variable A x B	2.1	1	2.1	1.00
Error b	1341.6	16	83.8	
Within Subjects	1824.8	60		
Trials	1430.1	3	476.7	110.86
Trials x A	112.6	3	37.5	8.72
Trials x B	55.1	3	18.4	4.28
Trials x A x B	21.4	3	7.1	1.65
Error w	205.6	48	4.3	

We conclude that somatype (ectomorph and mesomorph) was a significant factor in reducing stomach acid. All subjects learned to reduce acidity over trials. The rate of learning depended on music, the rate also depended on somatype.

For additional reading consult:

Bruning, James, and Kintz, B. J. Computational Handbook of Statistics.

Glemier, Illinois: Scott, Foresman and Co., 1977.

Dayton, C. Mitchel. The Design of Educational Experiments. New York:

McGraw-Hill Book Co., 1970.

Unit 4

Analysis of Covariance

Among the statistical devices examined thus far, the analysis of covariance is the most sophisticated. Recall that in our discussions on experimental design one of the true experimental designs was the pre-test and post-test design. Diagrammed, the pre-test and post-test design appears:

R	O ₁	X	O ₂
R	O ₃		O ₄

Preliminarily, subjects are randomly selected and assigned to either an experimental or control group. This design prescribes that after the assignment to groups, subjects of both groups are administered a pre-test and a post-test, with subjects assigned to the experimental group receiving some type of experimental treatment.

The data of the pre-test and post-test design could be analyzed either by a series of t-tests comparing the pre-test and post-test scores for both groups, or more efficiently a 2 X 2 mixed effects analysis of variance. However, if you suspect that the groups were initially not equal, then comparing their test scores would be misleading. The analysis of covariance allows a researcher to evaluate the test results of groups which initially were not equivalent. For example, a researcher might be interested in evaluating the

performance of subjects from different school systems on two different treatments or educational approaches.

Huck and Cormier (1977) describe the advantages of using the analysis of covariance as: (1) it allows comparison of groups which are not initially equal and (2) the analysis of covariance is a very robust device.²¹⁴

Although covariance is very similar to the analysis of variance, there are some differences. Covariates are measures used to make initial observations on a subject. This process can be called a pre-test. The pre-test may or may not be the same as the post-test. If the covariate is not the dependent variable (measured behavior), then it must be correlated "with the dependent variable." For example, a researcher might use the Seashore rhythm subtest and the rhythm subtest of the Gaston Test of Musicality as covariates. It is imperative that the two subtests be related. Why would a researcher not want to use the same measure as a pre-test and a post-test? It should be noted that for every type of analysis of variance, there is an analysis of covariance as a counterpart. The main differences are the covariate measures and the degrees of freedom.

The relationship between the covariate and the dependent variable is referred to variously as common slope, homogeneous regression coefficient, or homogeneity of regression. In addition, when the size

²¹⁴Schuyler W. Huck et al., Reading Statistics and Research (New York: Harper & Row Publishers, 1974), pp. 210-215.

of the groups is not equal, a test of homogeneity of variance is appropriate (See sections 3.1, 3.2, and 3.3 in Bruning and Kintz). The assumption of linearity, also associated with analysis of covariance, states that the relationship between covariates and the dependent variable must be a straight line relationship not a curvilinear relationship. Huck and Cormier express this as a relationship between height and weight because a gain in height will produce a proportionate gain in weight.

Example

Students in a music therapy department were randomly assigned to three groups: T_1 , T_2 , and T_3 where T represented teaching methods. T_1 represented traditional lecture method, T_2 represented an open seminar discovery method, and T_3 represented a model where the students were given a series of programmed units on music therapy literature. Initially, the subjects were administered the practice form of a music therapy examination. These data are represented by the x variable. The y variable represented scores on a National Certification Examination for Music Therapy.

STEP 1. Array the scores.

T_1 - Traditional			T_2 - Open Seminar			T_3 - Programmed Units		
Students			Students			Students		
X	Y		X	Y		X	Y	
S_1	32	62	S_7	21	72	S_{13}	38	95
S_2	46	66	S_8	24	85	S_{14}	45	88
S_3	27	64	S_9	18	61	S_{15}	52	104
S_4	35	48	S_{10}	32	87	S_{16}	48	86
S_5	31	51	S_{11}	35	69	S_{17}	41	72
S_6	40	74	S_{12}	26	74	S_{18}	37	63

STEP 2. Total each of the columns.

T_1		T_2		T_3	
X	Y	X	Y	X	Y
211	365	156	448	261	508

STEP 3. Square the scores in the x column and total the results.

$$32^2 + 46^2 + \dots + 41^2 + 37^2 = 23,448$$

STEP 4. Total the scores of each of the x columns.

$$211 + 156 + 261 = 628$$

STEP 5. Square the value achieved in Step 4, and divide the product

by the total number of scores in the x columns.

$$628^2/18 = 21,910.22$$

STEP 6. Subtract Step 5 from Step 3.

$$23,448 - 21,910.22 = 1537.78$$

STEP 7. From Step 4, square the scores from each of the x columns and divide by the number of scores in a single group (most examples reviewed have an equal number of subjects in the various methods).

$$\frac{211^2 + 156^2 + 261^2}{6} = \frac{136,978}{6} = 22,829.667$$

STEP 8. Subtract the value of Step 5 from the above value (Step 8).

$$22,829.667 - 21,910.22 = 919.445$$

STEP 9. Subtract the value of Step 8 from Step 6.

$$1537.778 - 919.445 = 618.33$$

STEP 10. Repeat the above procedure for the y variable. Square all of the scores in the y columns.

$$62^2 + 66^2 + \dots 72^2 + 63^2 = 100,747$$

STEP 11. Total the scores of each of the y columns.

$$365 + 448 + 508 = 1321$$

STEP 12. Square the value of Step 11 and divide by the number of scores in the y columns.

$$1321^2/18 = 96,946.722$$

STEP 13. Next, subtract the value obtained in Step 12 from the value of Step 10.

$$100,747 - 96,946.722 = 3800.278$$

STEP 14. After totaling the scores in the y columns, square each column total and divide by the number of scores in the column. Next, add the results.

$$\frac{365^2 + 448^2 + 508^2}{6} = 98,665.5$$

STEP 15. From Step 14 subtract the value in Step 12.

$$98,665.5 - 96,946.725 = 1718.778$$

STEP 16. From Step 13 subtract the value in Step 15.

$$3800.278 - 1718.778 = 2081.5$$

STEP 17. Obtain the sum of the cross products of x and y by multiplying each x by its y counterpart and totaling the results.

$$(32 \times 62) + (46 \times 66) + \dots (37 \times 63) = 47,131$$

STEP 18. Multiply the total sum of the x scores (Step 4) by the total sum of the y scores, (Step 11) and divide by the number of scores in the study.

$$\frac{628 \times 1321}{18} = 46,088.22$$

STEP 19. From the value in Step 17 subtract the value from Step 18.

$$47,131 - 46,088.222 = 1042.778$$

STEP 20. Multiply the sum of the scores for each of the x columns by its corresponding column total, add the results, and divide by the number of scores per group.

$$\frac{(211 \times 365) + (156 \times 448) + (261 \times 508)}{6} = 46,581.833$$

STEP 21. From Step 20 subtract the value obtained in Step 18.

$$46,581.833 - 46,088.222 = 61$$

STEP 22. From Step 19 subtract the value in Step 21.

$$1042.78 - 493.61 = 549.17$$

STEP 23. Square the results of Step 19 then divide the result by Step 6.

$$\frac{(1042.79)^2}{1537.79} = 707.12$$

STEP 24. From Step 13 subtract Step 23.

$$3800.28 - 707.12 = 3093.16$$

STEP 25. Square Step 22, divide the resulting value by Step 9.

$$549.17/618.33 = 487.74$$

STEP 26. From Step 16 subtract Step 25.

$$2081.5 - 487.74 = 1593.76.$$

STEP 27. Where N equals the total number of pairs (x y), and a the number of experimental groups divide Step 26 by the degrees of freedom term $N - a - 1$.

$$\frac{1593.76}{N-a-1} = \frac{1593.76}{18-3-1} = \frac{1593.76}{14} = 113.84$$

STEP 28. From Step 24 subtract Step 26.

$$3093.16 - 1593.76 = 1499.40$$

STEP 29. Calculate the between group degrees of freedom ($a - 1$), where a equals number of treatment conditions - 1. Here,
 $a - 1 = 3 - 1 = 2$

Divide the value of Step 28 by $a - 1$.

STEP 30. Calculate the F ratio by dividing Step 29 by Step 27.

$$F = \frac{749.7}{113.84} = 6.59$$

After consulting the appropriate statistical table we find that an $F = 6.59$ is significant at the .01 level. We conclude that there is a significant effect due to the effects of the teaching method.

In the analysis of covariance, a test of homogeneity of regression is normally computed. By extracting the data from the computation already completed, the steps are as follows.

STEP 1. To compute the sum of squares x (SS_x), square each score in Group 1 and add the results.

$$32^2 + 46^2 + \dots 40^2 = 7655$$

Next add the scores in Group 1. Square the result and subtract from the above figure.

$$x^2 - \frac{(\sum x)^2}{n}$$

$$7655 - \frac{(211)^2}{6} = 234.8$$

Repeat for each group.

$$4266 - \frac{(156)^2}{6} = 210$$

$$11,527 - \frac{(261)^2}{6} = 173.5$$

Compute the SP value similarly.

Where, $SP = xy - x y/N$

and N equals the number of paired scores.

$$xy = (32) (62) + (46) (66) + \dots (40) (74) = 12,969$$

$$\text{Group 1} = 12,969 - \frac{211 \cdot 365}{6} = 133.2$$

$$xy = (21) (72) + (24) (85) + \dots (26) (74) = 11.773$$

$$\text{Group 2} = 11,773 - \frac{156 \times 448}{6} = 125.0$$

$$xy = (38) (95) + (45) (88) + \dots (37) (63) = 22,389$$

$$\text{Group 3} = 22,389 - \frac{261 \times 508}{6} = 291.0$$

STEP 3. To compute SP^2/SS_x for the groups

$$\text{Group 1} = \frac{\text{Step 2}}{\text{Step 1}} \quad (\text{For the appropriate group})$$

$$\text{Group 1} = \frac{133.2^2}{234.8} = 75.56$$

$$\text{Group 2} = \frac{125^2}{210} = 74$$

$$\text{Group 3} = \frac{291^2}{173.5} = 488.1$$

STEP 4. Sum the results of Step 3.

$$75.56 + 74 + 488.1 = 638$$

STEP 5. Compute the error term for SS_y . From Step 16 of the covariance calculation, subtract the previous Step 4.

$$2081.5 - 638 = 1443.5$$

STEP 6. Where degrees of freedom equal $df = N - 2a$ and N equals the number of pairs and a the number of treatments;

$$df = 18 - 2(3) = 18 - 6 = 12$$

Divide Step 5 by $N - 2a$

$$\frac{1443.5}{12} = 120.3$$

STEP 7. Calculate the adjusted error sum of squares for y. See Step 26 of the original analysis and subtract Step 5 (this calculation).

$$1593.76 - 1443.5 = 150.26$$

STEP 8. Degrees of freedom for error equal a - 1. Here 3 - 1 = 2.

Divide Step 7 by degrees of freedom for error.

$$150.26/2 = 75.13$$

STEP 9. Determine the F ratio by dividing Step 8 by Step 6.

$$\frac{75.13}{120.3} = .62$$

Consulting a F table of probability with degrees of freedom equal to 2 and 12 we find that our F ratio is not significant. We therefore conclude that the group regressions were homogeneous.

For additional reading consult:

Dayton, C. Mitchel. The Design of Educational Experiments. New York: McGraw-Hill, 1970.

Edward, Allen S. Multiple Regression and the Analysis of Variance and Covariance. San Francisco: W. H. Freeman Co., 1979.

Unit 5

Multiple Correlation and Regression

The statistical devices covered in each of the previous units have been easy tasks for a pocket calculator or a microcomputer. Even the mixed designs, however lengthy and tedious, can be calculated by either of the two. Multiple correlation is not easily computed on either of the small devices, and, in the case of the discriminant function analysis (Unit 6), computation can be accomplished only on the computer.

There are many similarities between these two statistical approaches. The mathematician will note that the two approaches have virtually identical mathematical bases except that multiple correlation uses a continuous criterion variable while discriminant function analysis uses a categorical criterion variable. Several new terms (criterion variable and predictor variable) are used with these two designs. In the literal sense, the criterion is a behavioral measure of future performance to be predicted using a set of variables which presently are being measured. For example, the criterion measured might be whether a person will be a successful or unsuccessful therapist (a categorical criterion variable) or job satisfaction might be measured on a scale of one to ten (a continuous criterion variable). The predictor variables are those variables chosen to statistically predict the criterion variable, such as the sex of the therapist,

number of years of practice, age, or annual salary.

Despite these similarities between multiple correlation and discriminant function analysis, there is at least one major difference. The two techniques are used with different research designs. Multiple correlation is a correlational technique used when there is a single criterion and multiple predictors measured from a single group of subjects. It is essentially correlational, attempting to determine a relationship between variables, or possibly attempting to predict the criterion because of this relationship. The discriminant function analysis, on the other hand, is used with quasi-experimental designs, or with experimental designs having several groups of subjects where the researcher wants to test whether the groups are different in terms of the set of predictor variables. The research question underlying discriminant function analysis is one of significant difference between groups, even though the researcher using this technique may later want to predict the group membership of certain subjects.

Since the multiple correlation and multiple regression techniques in this unit are advanced correlational techniques, it is necessary that the student be thoroughly familiar with simple correlation and regression. Correlation refers to relationship, or to the extent to which variables go together (covary), or measure the same thing.

Correlation is expressed statistically as a coefficient ranging

from -1.00, thru 0.00, to +1.00, where the absolute value of the coefficient (0.00 thru 1.00) expresses the strength of the relationship, and the sign (+ or -) expresses whether the two variables covary in the same or opposite directions. The most common correlation coefficient is the Pearson product moment correlation, which is expressed as an "r" and is used when the variables are intervallic (other assumptions must also be met in order to use a Pearson r).

Simple correlation describes the most elementary model in which two variables are being related. Simple correlation is referred to as bivariate correlation. In bivariate correlation one variable is being correlated with another; if these two are related, one can be predicted from the other. Multiple correlation presents a different model in which one variable (the criterion) is being correlated with a set of variables (the predictors). It should be emphasized that a set of variables, or more accurately a weighted set of variables, are being treated as a whole unit correlated with the single variable. Multiple correlation produces a single statistical measure of relationship, the multiple correlation coefficients usually written as an upper case R (i.e., $R = .86$).

Regression is an extension of correlation when the aim is to develop an equation which actually predicts values of the criterion variable. Regression analysis is performed after correlation analysis, but only when there is a significant relationship and the aim is prediction. Simple regression attempts to predict one variable from

another (bivariate regression), multiple regression aims to predict a criterion from a set of predictor variables. Regression equations can be used to predict actual values of a criterion variable if the researcher knows the actual values of the predictor variables. Regression equations also can be used to compare the relative importance of each variable in the equation.

Example

The following data are taken from the Computational Handbook of Statistics by Bruning and Kintz.

With a criterion variable being freshman grade point average, and the two predictor variables being high-school grades and entrance-examination scores, a multiple correlation coefficient (R) was determined. It was necessary to compute the relationship between freshman grade point average (GPA), and the criterion variable using two predictors (high school grades and entrance examination). The simple correlations are as follows: $r_{12} = +.60$ between GPA and school grades, $r_{13} = +.50$ between GPA and college entrance scores, and $r_{23} = .70$ between high school grades and entrance examination. The size of the multiple correlation will depend upon how well the combination of predictors (high school grades and entrance examination scores) predict performance (GPA). The relationship is expressed in the following equation.

$$R_{1.23} = \frac{r_{12}^2 + r_{13}^2 - 2r_{12} r_{13} r_{23}}{1 - r_{23}^2}$$

$$R_{1.23} = \frac{.60^2 + .50^2 - 2(.60)(.50)(.70)}{1 - .70^2}$$

$$R_{1.23} = \frac{.36 + .25 - 1.20(.50)(.70)}{1 - .49}$$

$$R_{1.23} = \frac{.61 - 1.20(.35)}{.51}$$

$$R = .61$$

STEP 1. Using simple correlation (Pearson r), compute the correlation between three variables: GPA, high school grades, and entrance examination scores.

STEP 2. Substitute into the formula as already shown.

In the above problem, an $R = .61$ is larger than either of the variables taken singularly. It should be noted that if the correlation between each of the predictors and the criterion is unchanged, then R will have become larger; conversely, if the value between the predictors and the criterion variable is larger, then R will have decreased.

Multiple Regression

Simple prediction can be described by the equation:

$$Y_1 = .15 + 70X \quad Y_1 = 70X + .15$$

where Y_1 = the variable to be predicted (1st semester GPA, for example), X = (high school GPA, for example), and .15 is a constant provided in the equation on which the raw score already is known.

Using our new language, the Y variable in this equation is the criterion or dependent variable, and X is called the predictor or independent variable. In regression, the efficacy of the equation depends upon the degree of correlation between the predictor and criterion variables. For example, if high school GPA was correlated $r = .65$ with college GPA and IQ was correlated $r = .90$ with college GPA, we would use IQ because it is a better predictor of 1st semester GPA. In conclusion, we attempt to construct the best equation by using the best predictors. Computer-based regression programs actually do this for the researcher, selecting and ordering the variables in such a way as to maximize the size of the R .

The coefficient of determination identified as r^2 or R^2 , describes the amount of common or shared variance between variables. It is for this reason that multiple predictors are used; they can account for more of the variance between the groups.

B Weights and Beta Weights

Regression equations actually come in two very similar forms, standardized and non-standardized forms. The equation examined earlier ($Y = 70X + .15$) is a non-standardized regression equation. An example of a non-standardized multiple regression equation would be:

$Y = .35X_1 + .68Y_2 + 7.35$. This form of the regression equation is used when actual raw scores are substituted into the equation in an attempt to predict an actual Y score. For this reason, nonstandardized regression equations are also referred to as raw score regression formulas. The weights given to each predictor variable are termed raw score regression weights, or B weights. B weights are used only when the purpose is to predict a value for Y; B weights cannot be compared directly with each other.

The second form of the regression equation is the standardized regression equation. Multiple, rather than simple standardized regression equation will be used in the following example: $Y = .35X_1 + .48Y_2 + .12Y_3$. This equation contains three predictor variables, each with its own weight. The weights in standardized regression formulas are called standard regression weights, or Beta (B) Greek weights for short. Unlike the B weights, beta weights are directly comparable with each other. This allows the researcher to compare directly the importance of each predictor variable. This equation, however, cannot be used to predict actual scores on the Y variable unless standardized (z) scores are used. One additional difference between non-standardized and standardized regression equations is that the standardized equation puts the constant at the end of the equation.

Probability Levels Associated with R

In multiple regression, as with the t-test or analysis of variance (F), the researcher is interested in probability testing. Since

any number of prediction equations can be drawn, we are comparing our equation to one drawn on the basis of chance.

Cross Validation

Since the application of R^2 is not based on the individuals whose scores the investigator is trying to predict (they are not yet known), any prediction is only that, a prediction, an educated guess. A technique used to test the equation with new individuals is called cross-validation. One way to accomplish cross-validation is to randomly split the original group in half, develop a prediction equation based on half of the sample, and use the equation to predict the scores of the second group. Since this is a known sample, the researcher has the actual scores of the entire group. Therefore, the predicted scores can correlate with actual scores. If these scores are highly correlated, the equation possesses some validity, it produces predicted scores which are very similar to the actual scores.

Unit 6

Discriminant Function Analysis

As stated in the previous unit, regression attempts to statistically predict performance on a single variable from a set of variables. In regression analysis, the criterion variable is continuous. Discriminate function analysis attempts to predict group membership on the basis of a set of variables. The criterion variable in discriminant function analysis is categorical, dichotomous, or nominal. Note that a nominal criterion variable is not restricted to two categories. For example, a clinician might be interested in predicting IQ classifications (mild, moderate, severe, and profound) of mental retardates on the basis of pitch matching ability or rhythmic perception. Relatedly, a researcher might be interested in predicting successful readjustment to the community after having been discharged from the hospital for over a year. The predictors used in this study might be participation in music and activities therapy sessions, the number of close friends reported by the clients before hospitalization, and membership in community organizations. In the first example the clinician is attempting to predict membership in one of the four IQ classification groups, in the second sample the researcher is predicting membership in only two groups - successful adjustment versus unsuccessful adjustment.

Simple Discriminant Function Analysis

The researcher in the above example, who was interested in

predicting successful and unsuccessful community adjustment, would have used a simple discriminant function analysis, or a two group discriminant function analysis. Put another way, he was "interested in predicting to a dichotomous criterion variable."²¹⁵ The predictor variables in the above study were attendance at therapeutic activities, the number of close friends reported before hospitalization, and the number of memberships held in community organizations. If the above data were analyzed by the SPSS subprogram Discriminant, besides the normal information supplied for any analysis, the computer would yield information concerning the size of the groups, means for each of the predictor variables, the eigenvalues, a Wilks' Lambda Statistic, an F-ratio, and a significance level.

From the above list, only the eigenvalues and the Wilks' Lambda should be unfamiliar. Nie et al. state that the SPSS subprogram Discriminant provides the use with two measures which assess the importance of a particular discriminant function.²¹⁶ One of these, the eigenvalue, measures the relative importance of a particular function. The sum total of the eigenvalues yields the total variance. Expressed in terms of percentages, the eigenvalues are computed in order of

²¹⁵Schuyler W. Huck et al., Reading Statistics and Research (New York: Harper & Row Publishers, 1974), pp. 148-176.

²¹⁶Norman H. Nie et al., Statistical Package for the Social Sciences, 2nd ed. (New York: McGraw Hill Publishing Company, 1975), p. 442.

importance, so that the researcher may decide at some point that he feels the value is too small and not worth continuing.

The other value is a measure of the discriminating values not already computed. Called Wilks' Lambda, it is an inverse of the discriminating power of measures not yet used. With a large Lambda, a little amount of information is remaining. To test the significance of the Wilks, a chi square is computed. As discriminant functions are added to the equation, Lambda will increase and its corresponding chi square will decrease, thus lowering the probability level. The term centroid is also encountered in the discriminant function analysis. Centroids are achieved by taking the means of the respective groups for a particular function. If we determine the means for a particular group on all of the functions, we would have determined the group centroids.

Multiple Discriminant Function Analysis

For most of this unit, we have restricted our discussion to the simple or two group discriminant function analysis. When a researcher is interested in predicting membership to three or more groups, a multiple discriminant function analysis is used. It is emphasized that the number of predictor variables (dependent variables) may remain unchanged, but group membership might be divided into more than two groups. In the above example, attendance at therapy sessions, number of friends reported before hospitalization, and community involvement could still be used as predictors. This time, however, it might desire

to predict successful adjustment (no re-hospitalization after a year) and unsuccessful adjustment (more than two re-hospitalizations in a year). Remember, the number of predictors remain the same, only the number of categories or criterion groups has changed. The same statistics, such as centroids, eigenvalues, and Wilks' Lambdas are also present in the multiple discriminant function analysis.

Example

Field experience during academic training is an integral part of most professions, and music therapy is no exception. However, clinicians and educators are frequently at a loss in their efforts to develop evaluative devices sensitive enough to describe the experience. To this end, the faculty members in a music therapy department devised an eleven item evaluation form. The items included attendance/punctuality, ability to follow directions, ethical behaviors, and functional music ability. A ten-point scale was used to rate performance on each item. In order to test the discriminating powers of the scale, seventeen clinicians and fifteen educators were asked to evaluate job performance. All of the forms were completed at the end of the semester. A simple discriminant function analysis was used to predict membership in the two groups (student, clinician) on the basis of the answers given to the eleven items.

A computer print-out of the above example appears at the end of this unit. The student should have guessed by now that the discriminant function analysis is not calculated with a desk calculator.

Please note the steps and format of the instructions given to the computer for the computation of this problem. Also note the manner in which the data appear.

Table 22

"Run" file entitled PACTRUN.

```

1  !JOB TONY/ .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      DISCRIM ANAL ON PRACTICUM DATA
4  VARIABLE LIST Q1 TO Q11, GROUP
5  INPUT MEDIUM DISC(PRACTDAT)
6  N OF CASES    32
7  INPUT FORMAT  FIXED(11F2.0,X,F1.0)
8  VALUE LABEL   GROUP (0)STUDENTS (1)CLINICIANS
9  DISCRIMINANT  GROUPS=GROUP(0,1)/VARIABLES=Q1 TO Q11/
10 ANALYSIS=Q1 TO Q11/PRIORS=SIZE
10.1  OPTIONS    5,7,8,10,11,12
10.2  STATISTICS 1,5,6
11  FINISH
12  !EOJ

```

Table 23

"Data" file entitled PRACTDAT.

1	0810091009101010100909	0
2	0710101008101010101009	0
3	0808080907080809070708	0
4	1010100908090808081008	0
5	0910101008101009091010	0
6	0910091009101009101009	0
7	1010080907090808080908	0
8	1010101010101010101010	0
9	0909070807080708080809	0
10	0609101009090910090909	0
11	0910101008100909081009	0
12	0910100908100807091009	0
13	0810101007100809091010	0
14	1010101009100910091010	0
15	1010101008101010091010	0
16	1010101010101010091009	1
17	1010081009100906080909	1
18	0909101009100809090908	1
19	0910091008101008101009	1
20	0709090908090807070709	1
21	0910090908100908090907	1
22	1010091008100807090908	1
23	0809091008100807080808	1
24	1010101010101010101010	1
25	1010101008090708081008	1
26	0709090908090909080908	1
27	0909101008090908080807	1
28	1010101008100609090908	1
29	1010101008100908101008	1
30	0910101009100910101009	1
31	0909101009100810091009	1
32	1010081009100806081009	1

Note that this is a numbered file with the number of cases being represented by the first column. There are eleven columns of two digit numbers with zeros being used to make the numbers compatible. The last single digit column (0, 1) is the group membership code.

Table 24

Group Means for Discrim Problem

GROUP MEANS			
GROUP	Q1	Q2	Q3
0	8.80000	9.73333	9.40000
1	9.17647	9.64706	9.41176
TOTAL	9.00000	9.68750	9.40625
Q4	Q5	Q6	Q7
9.60000	8.13333	9.53333	8.93333
9.82353	8.52941	9.76471	8.52941
9.71875	8.34375	9.65625	8.71875
Q8	Q9	Q10	Q11
9.06667	8.86667	9.46667	9.13333
8.23529	8.76471	9.23529	8.41176
8.62500	8.81250	9.34375	8.75000

Results

DISCRIM ANAL ON PRACTICUM DATA

WILKS' LAMBDA (U-STATISTIC) AND UNIVARIATE F-RATIO
WITH 1 AND 30 DEGREES OF FREEDOM

VARIABLE	WILKS' LAMBDA	F	SIGNIFICANCE
Q1	.97028	.9190	.3454
Q2	.99332	.2018	.6565
Q3	.99995	.1524E-02	.9691
Q4	.95298	1.480	.2333
Q5	.94108	1.878	.1807
Q6	.96197	1.186	.2848
Q7	.96228	1.176	.2868
Q8	.88405	3.935	.0565
Q9	.99667	.1002	.7537
Q10	.98308	.5162	.4780
Q11	.81141	6.973	.0130

Table 26
DISCRIM ANAL ON PRACTICUM DATA

CANONICAL DISCRIMINANT FUNCTIONS				
FUNCTION	EIGENVALUE	PERCENT OF VARIANCE	CUMULATIVE PERCENT	CANONICAL CORRELATION
1*	1.24676	100.00	100.00	.7449262
AFTER FUNCTION	WILKS' LAMBDA	CHI-SQUARED	D.F.	SIGNIFICANCE
0	.4450850	19.833	11	.0477

Table 27

CANONICAL DISCRIMINANT FUNCTIONS EVALUATED

AT GROUP MEANS (GROUP CENTROIDS)

GROUP	FUNC 1
0	-1.15095
1	1.01554

Table 28

CLASSIFICATION RESULTS

ACTUAL GROUP		NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
			0	1
GROUP STUDENTS	0	15	13 86.7%	2 13.3%
GROUP CLINICIANS	1	17	5 29.4%	12 70.6%

PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 78.13%

CLASSIFICATION PROCESSING SUMMARY

32 CASES WERE PROCESSED.

32 CASES WERE USED FOR PRINTED OUTPUT.

Unit 7

Non-Parametric Statistics

Non-parametric statistics, or the so-called "distribution-free" tests, differ from their parametric counterparts in that they make no assumptions about the population from which the subjects were drawn and are based on the normal distribution. A second distinguishing characteristic is that they are intended for use on variables which are only nominal or ordinal. The non-parametric tests are particularly suitable for the behavioral sciences since the samples are often small, and the data are often not numerical, but are amenable to ranking procedures. Another advantage of the non-parametric devices is the simplicity in computation. In summary, the advantages found in the use of non-parametric statistical tests are:

- (1) distribution-free, no assumptions about population
- (2) nominal and ordinal scales of measurement are adequate
- (3) amenable to non-numeric data, and small samples
- (4) computational simplicity

One major use of non-parametric statistics has been to substitute them for the more powerful parametric statistics when the parametric assumptions could not be met.

It is appropriate here to discuss the criticism levelled at the use of non-parametric statistics. Boneau (1960) in his article, "The Effects of Violations of the Assumptions Underlying the t-test,"

states that in most instances minor violations of either of the assumptions of homogeneity of variance and normality do not significantly alter the value of the t ratio.²¹⁷ Anderson (1961) reports that t and F are the major statistical devices in psychology and related fields, with the non-parametric tests being of minor importance.²¹⁸ This opinion is borne out in a survey of the papers published in the Journal of Music Therapy from 1975 to 1980. The results of that survey indicated that various types of analyses of variance were used more extensively than any other type of statistical device, with the t-test in close pursuit.²¹⁹ The Newman-Keuls was the most widely used post-ANOVA test. Still the non-parametric tests warrant discussion because the sample sizes often used in music therapy research are small and use of non-numeric data is frequent.

The Tests

The non-parametric devices to be studied were selected on the basis of a recent nationwide survey of music therapy professors.

²¹⁷ C. Alan Boneau, "The Effects of Violations of Assumptions Underlying the t-test," Readings in Statistics (Massachusetts: Addison-Wesley Publishing Co., 1970), p. 231.

²¹⁸ Norman Anderson, "On Teaching F-instead of t," Readings in Statistics (Massachusetts: Addison-Wesley Publishing Co., 1970), p. 106.

²¹⁹ Anthony A. Decuir, "A Survey of Statistical Course Offerings in Music Therapy," paper presented at the 31st Annual Conference of the National Association for Music Therapy, Minneapolis, Minnesota, 4 November 1980. (Mimeographed.)

Results of the survey indicated that the following non-parametric statistics were the most useful for music therapy students:

1. Chi square (nominal)
2. One-sample runs test (ordinal)
3. Kolmogorov-Smirnoff one sample runs test (ordinal)
4. Mann-Whitney U (ordinal)
5. Wilcoxon matched-pairs signed-rank test (ordinal)
6. McNemar test for the significance of changes (nominal)
7. Kolmogorov-Smirnoff two sample test (ordinal)
8. Chi square test for two independent samples (nominal)
9. Friedman two-way analysis of variance (ordinal)
10. Chi square test for k independent samples (nominal)
11. Kruskal-Wallis one-way analysis of variance (ordinal)

The devices listed above are grouped according to the samples for which they are appropriate, that is, one-sample cases, two-sample cases, and k-sample cases.

Until recently, there were no SPSS sub-programs for non-parametric statistics. Now, however, most of the frequently used non-parametric statistical tests have been included in SPSS. All of the non-parametric devices reviewed in this course are included in the recent SPSS Update (7 and 8).

Chi Square One-Sample Test (nominal)

The chi square test (χ^2) is a goodness-of-fit test; it attempts

to determine whether there are significant differences between an observed number of responses and an expected number under the null hypothesis (H_0). The one-sample tests attempt to determine whether a particular sample was actually drawn from a particular population.

For example, a music therapist might be interested in categorizing mentally retarded clients according to their preference for a particular type of musical activity.

Methodology

To make the comparison between an observed frequency and an expected frequency, it is necessary first to determine the expected frequency. The expected frequency in each cell equals the total number of observations (N) divided by the number of categories (k), or $E_i = N/k$.

In order to test whether the observed frequency is different from the expected frequency, that is, whether the sample was drawn from the same or a different population, the following formula is used:

$$\chi^2 = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i}$$

where O_i = observed number of cases

E_i = expected number of cases

$\sum_{i=1}^k$ = sum the result from each of the k cells

The larger the value of X^2 , the more likely it is that the sample in question was not drawn from the population. The significance of X^2 can be determined from a chi square table if the degrees of freedom are known. Degrees of freedom are defined in the one-sample situation as the number of categories minus 1, or $df = k - 1$.

Example

A music therapist investigated the effects of preferred and non-preferred music on finger temperature. This investigator tried to determine which of the five fingers of the dominant hand achieved a particular criterion temperature within 5 seconds. In this example, the expected frequencies are defined by multiplying the observed frequencies by the number of categories.

	Fingers of Dominant Hand					Total
	1	2	3	4	5	
Expected f	7.2	7.2	7.2	7.2	7.2	
Achieved criterion	5	10	8	7	6	36

$$X^2 = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i}$$

"Run" file entitled FINGRRUN; "data" file entitled FINGRDAT.

```

1  !JOB TONY/ .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      CHI SQUARE ONE SAMPLE FINGER PROBLEM
4  VARIABLE LIST DV
5  INPUT MEDIUM DISC(FINGRDAT)
6  N OF CASES    36
7  INPUT FORMAT  FIXED(F1.0)
8  NPAR TESTS    CHI-SQUARE = DV(1,5)
9  FINISH
10 !EOJ

```

1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	2
9	2
10	2
11	2
12	2
13	2
14	2
15	2
16	3
17	3
18	3
19	3
20	3
21	3
22	3
23	3
24	4
25	4
26	4
27	4
28	4
29	4
30	4
31	5
32	5
33	5
34	5
35	5
36	5

Table 30

Results of FINGERDAT Analysis

CHI-SQUARE TEST					
DV					
VALUE	1.	2.	3.	4.	5.
COUNT	5.	10.	8.	7.	6.
EXPECTED	7.20	7.20	7.20	7.20	7.20
CHI-SQUARE			D.F.	SIGNIFICANCE	
2.056			4	.726	

$$\begin{aligned} \chi^2 = & \frac{(7.2 - 5)^2}{7.2} + \frac{(7.2 - 10)^2}{7.2} + \\ & \frac{(7.2 - 8)^2}{7.2} + \frac{(7.2 - 7)^2}{7.2} + \\ & \frac{(7.2 - 6)^2}{7.2} \end{aligned}$$

$$\chi^2 = 2.06$$

$$df = k - 1$$

$$5 - 1 = 4$$

$$p > .05$$

The One-Sample Runs Test (ordinal)

Often a researcher is interested in determining whether a sample drawn from a particular population is in fact a random selection. In order to determine whether a sample has been randomly selected, a method founded on a sequential or ordering technique is used.

The One-Sample Runs Test is based on counting the number of runs presented by a sample. A run is defined here as a sequence of symbols, typically, pluses (+) and minuses (-). For example, the following series would yield seven runs:

$$\begin{array}{ccccccc} - & +++ & -- & + & - & + & - \\ 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{array}$$

Here $r = 7$, $n_1 = 4$, and $n_2 = 3$

Methodology

Where n_1 and n_2 represent the number of a particular sign, the total number of observations are yielded by the formula $N = n_1 + n_2$.

For samples where n_1 and n_2 are each less than twenty cases, the value of r in the runs test is equal to number of changed signs. For samples with either n_1 or n_2 larger than 20, a z score must be computed.

An experimenter interested in studying aural acuity among cerebral palsied clients observed the clients in dyadic play situations. Thirty (30) clients were selected to participate in the study. Fearing contamination of the screening procedure by clients conversing with one another, the experimenter attempted to determine the randomness of the sample. Having completed the selection process, each subjects' score was compared to the mean score of the sample.

Table 31

Aural Acuity Scores

Client	Score	Score in regard to ($\bar{X} = 20 - 13$)
1.	40	+
2.	15	-
3.	22	+
4.	18	-
5.	19	-
6.	35	+
7.	20	-
8.	8	-
9.	15	-
10.	27	+

Table 31--(Continued)

Client	Score	Score in regard to ($\bar{X} = 20 - 13$)
11.	15	-
12.	6	-
13.	29	+
14.	27	+
15.	41	+
16.	20	-
17.	10	-
18.	15	-
19.	22	+
20.	13	-
21.	5	-
22.	6	-
23.	26	+
24.	17	-
25.	16	-
26.	9	-
27.	35	+
28.	34	+
29.	8	-
30.	31	+

For samples where either n_1 or n_2 are larger than 20, the null hypothesis is tested by the formula:

$$r = \left(\frac{2n_1n_2}{n_1 + n_2} \right) + 1$$

$$z = \frac{\sqrt{2n_1n_2 (2n_1n_2 - n_1 - n_2)}}{(n_1 + n_2)^2 (n_1 + n_2 - 1)}$$

```

1  !JOB TONY/ .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      RUNS PROBLEM
4  VARIABLE LIST DV
5  INPUT MEDIUM DISC(RUNSDATT)
6  N OF CASES    30
7  INPUT FORMAT  FIXED(F2.0)
8  NPAR TESTS    RUNS (MEAN) = DV
9  FINISH
10 !EOJ

```

1	40
2	15
3	22
4	18
5	19
6	35
7	20
8	08
9	15
10	27
11	15
12	06
13	29
14	27
15	41
16	20
17	10
18	15
19	22
20	13
21	05
22	06
23	26
24	17
25	16
26	09
27	35
28	34
29	08
30	31

The two above files are entitled RUNSRUNN and RUNSDATT.

Table 33
Results of the Runs Test

- - - RUNS TEST				
DV				
CASES	TEST VALUE	RUNS	Z	2-TAILED P
30	20.1333	17.	.620	.535

At a glance . . .

1. Arrange the observations: n_1 = total number of pluses;
 n_2 = total number of minuses. Here $n_1 = +12$; $n_2 = -18$
 and $N = 30$.
2. Determine the runs (r) by counting them. r = the number of
 changed signs. Here $r = 17$.
3. Most tables for r require that the observed value be less
than or equal to the table value.
4. For n_1 or n_2 larger than 20, r is distributed similar to z .
5. $N = n_1 + n_2$ = the total number of scores.

Kolmogorov-Smirnoff One-Sample Test (ordinal)

The Kolmogorov-Smirnoff One-Sample Test is similar to the χ^2 one-sample test. It too is a goodness-of-fit test. Unlike the χ^2 test however, the Kolmogorov-Smirnoff one-sample test seeks to determine how an observed sample distribution compares with a theoretical distribution of the population.

The rationale underlying the Kolmogorov test is that if a sample were drawn from a certain population and the sample and the population scores plotted on a graph, under the null hypothesis (H_0) there would be no difference in their curves. The researcher needs to determine only the difference (D) to test the hypothesis.

The Kolmogorov-Smirnoff one-sample test is particularly useful in evaluating preferences for objects, opinions, individuals, or musical stimuli.

Methodology

To determine the maximum difference between the theoretical

population and the observed sample:

1. Plot the two distributions along similar points of comparison. These points may be percentiles, quartiles, z scores, etc.
2. The plotted distributions could look as follows:

Categories:	1	2	3	4	5	6	7	8	9	0
Preference:	4	0	0	0	2	4	0	0	0	0
*Theoretical Distribution	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
Sample Distribution	.4	.4	.4	.4	.6	1.0	1.0	1.0	1.0	1.0
Difference between theoretical and sample	.3	.2	.1	0	.1	.4**	.3	.2	.1	0

**Maximum Differences: D = .4

N = number of responses; here 10

$p < .10$

*Decimals were used here to make scores more compatible with the probability table.

Example

A clinician interested in determining the preferences of adolescent males for preferred sound levels of their favorite recordings set up the following experiment. The clients were exposed to five intensity levels of their favorite recordings. Ten clients participated (N=10).

Table 34

"Run" file entitled KOLGORUN.

1	!JOB TONY/ .DECUIR
2	!RUN SPSS.PUB.SPSS
3	RUN NAME KOLMOGOROV-SMIRNOFF PROBLEM
4	VARIABLE LIST DV
5	INPUT MEDIUM DISC(KOLGODAT)
6	N OF CASES 10
7	INPUT FORMAT FIXED(F1.0)
8	NPAR TESTS K-S (UNIFORM) = DV
9	FINISH
10	!EOJ

Table 35

"Data" file entitled KOLGODAT

1	4
2	0
3	0
4	0
5	2
6	4
7	0
8	0
9	0
10	0

Table 36

KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST

DV			
TEST DIST. - UNIFORM (RANGE = .0000 TO 4.0000)			
CASES	MAX(ABS DIFF)	MAX(+ DIFF)	
10	.7000	.7000	
K-S Z	2-TAILED P	MAX(- DIFF)	
2.214	.000	-.1000	

	<u>Recording Levels</u>					
	1	2	3	4	5	
Choices	4	0	2	3	1	= 10
Theoretical Choices	2	4	6	8	10	
Sample Distribution	4	4	6	9	10	
D	2/5	0	0	1/5	0	
D =	.4					
p <	.10					

Summary

The statistical devices presented in this unit are one-sample tests with χ^2 and Kolmogorov-Smirnoff described as goodness-of-fit tests. The one-sample runs test is useful for determining whether a drawn sample is a product of random selection. Both the one-sample runs and the Kolmogorov are suitable for at least ordinal data, while χ^2 is appropriate for nominal data.

Unit 8

In the next section, statistical devices appropriate for comparing two independent samples will be examined. These tests attempt to determine whether any significant differences exist between the two independent groups. Independent groups or samples can be defined as groups or samples selected separately, that is, from separate populations, or from populations whose characteristics are unknown.

The non-parametric tests selected are: chi square (X^2) (nominal), Kolmogorov-Smirnoff (ordinal), the Mann-Whitney U (ordinal).

Chi Square: Two Independent Samples

Often researchers are faced with comparing two independently drawn samples on some variable which is measured nominally. This comparison is attempted to determine if there is a significant difference between the two samples. For example, a music therapist might be interested in comparing the rhythmic perception abilities of males and females.

Methodology

As in the case of the chi square for goodness-of-fit, the present example is calculated similarly, that is,

$$X^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

The above formula requires that the expected frequency be calculated.

The expected frequency can be calculated by multiplying the sum of the rows by the sum of the columns and dividing by the total number of cases N. Quadrant A's expected frequency would be $(A + B) \times (A + C)/N$ or 7.8.

	Males	Females	
Succeed	A	B	A + B
Fail	C	D	C + D
	A + C	B + D	N = A + B + C + D

2 x 2 Contingency Table

	Males	Females	
Succeed	7.8 A	5.2 B	13
Fail	7.2 C	4.8 D	12
	15	10	25

The above example would yield the following calculations:

$$\begin{aligned}
 \chi^2 &= \sum \frac{(7 - 7.8)^2}{7.8} + \frac{(6 - 5.2)^2}{5.2} \\
 &\quad + \frac{(8 - 7.2)^2}{7.2} + \frac{(4 - 4.8)^2}{4.8} \\
 \chi^2 &= .41
 \end{aligned}$$

"Run" file entitled CHIS3RUN; "Data" file entitled CHIS3DAT.

```

1  !JOB TONY/ .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      CHI SQUARE 2 BY 2 PROBLEM
4  VARIABLE LSIT SUCCEED,GENDER
5  INPUT MEDIUM DISC(CHIS3DAT)
6  N OF CASES    25
7  INPUT FORMAT  FIXED(2F1.0)
8  VALUE LABELS  SUCCEED (1)SUCCEED (0)FAIL/
9                GENDER (1)MALE (2)FEMALE
10 CROSSTABS      TABLES = SUCCEED BY GENDER
11 STATISTICS     ALL
12 FINISH
13 !EOJ

```

1	11
2	11
3	11
4	11
5	11
6	11
7	11
8	01
9	01
10	01
11	01
12	01
13	01
14	01
15	01
16	12
17	12
18	12
19	12
20	12
21	12
22	02
23	02
24	02
25	02

Note that both files are numbered. The twenty-five cases as stipulated in the "run" file step 6. The data are to the right.

Table 38

CHI SQUARE 2 BY 2 PROBLEM

		GENDER				ROW TOTAL
		COUNT	I			
		ROW PCT	MALE	FEMALE		
		COL PCT	I	I		
		TOT PCT	I	1.1	2.1	
SUCCEED			-----I-----	I-----	I-----	
	0.	I	8	I	4	12
		I	66.7	I	33.3	48.0
		I	53.3	I	40.0	
FAIL		I	32.0	I	16.0	
			-----I-----	I-----	I-----	
	1.	I	7	I	6	13
		I	53.8	I	46.2	52.0
SUCCEED		I	46.7	I	60.0	
		I	28.0	I	24.0	
			-----I-----	I-----	I-----	
		COLUMN	15	10		25
		TOTAL	60.0	40.0		100.0
CORRECTED CHI SQUARE = .06010 WITH 1 DEGREE OF FREEDOM.						
RAW CHI SQUARE = .42735 WITH 1 DEGREE OF FREEDOM.						
SIGNIFICANCE = .8063						
SIGNIFICANCE = .5133						

An alternate formula with the correction for continuity appears as:

$$\begin{aligned}
 \chi^2 &= \frac{N (|AD - BC| - N/2)^2}{(A + B)(C + D)(A + C)(B + D)} \\
 &= \frac{25 (48 - 28)^2}{(13)(12)(15)(10)} \\
 &= \frac{25 (28 - 48)^2}{23400} \\
 &= \frac{25 (400)}{23400} \\
 \chi^2 &= .42
 \end{aligned}$$

Example

A music therapist employed at an institution for the physically handicapped was interested in investigating the likelihood that ataxic and athetoid patients preferred different intensities of music. Ten athetoid and 12 ataxic clients were randomly selected to participate in the study. After determining their musical preferences, the clients were exposed to three intensity levels of the music (60 db, 80 db, and 100 db). H_0 : there will be no differences in the choice of intensity levels of ataxic and athetoid clients for 3 (60, 80, 100 db) levels.

	Ataxic	Athetoid	
60 db	3.3 3	2.7 3	6
80 db	3.3 3	2.7 3	6
100 db	5.5 6	4.5 4	10
	12	10	22

Substituting into the formula, the data appear as follows:

$$\begin{aligned}
 \chi^2 &= \frac{(3 - 3.3)^2}{3.3} + \frac{(3 - 2.7)^2}{2.7} \\
 &+ \frac{(3 - 3.3)^2}{3.3} + \frac{(3 - 2.7)^2}{3.3} \\
 &+ \frac{(6 - 5.5)^2}{5.5} + \frac{(4 - 4.5)^2}{4.5} \\
 \chi^2 &= .21 \quad (\text{before rounding off } \chi^2 = .208)
 \end{aligned}$$

The advantages of the χ^2 for two independent samples are:

(1) ease of computation, (2) only nominal data required, and (3) a researcher is capable of setting the expected frequency on an a priori basis on a sample with which he is familiar. It must be emphasized, however, that chi square tests are limited to situations in which the categories are all independent; the occurrence of data from the same subject in two or more places in the analysis would violate the assumption and is probably the most frequent error in the use of the tests.

Kolmogorov-Smirnoff
Test for Two Independent Samples (ordinal)

The Kolmogorov-Smirnoff test for two independent samples, similar to its one-sample counterpart of the same name, attempts to determine differences between two independent samples on the basis of the maximum cumulative frequencies. The Kolmogorov-Smirnoff two-sample test is suited for at least ordinal data. Since the Kolmogorov-Smirnoff two-sample test examines the maximum cumulative frequencies along similar points in a distribution, it appears to be suitable for comparing designs which are based on a series of events.

For example, a researcher might be interested in examining differences in the scores of mentally retarded clients with I.Q.'s of 40 and 60. The two groups were compared on the basis of the Sea-shore rhythm test. The following are the raw scores, and the categories. The null hypothesis (H_0) states that there will be no differences in the two distributions.

Scores

MR - 40 I.Q.

5
8
9
6
7
6
5
11
8
9

MR - 60 I.Q.

15
21
12
9
14
15
17
18
9
10

"Run" file entitled KOLG02DAT.

```

1  !JOB TONY/ .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      KOLMOGOROV-SMIRNOFF TWO-SAMPLE
4  VARIABLE LIST IV,DV
5  INPUT MEDIUM DISC(KOLG2DAT)
6  N OF CASES    20
7  INPUT FORMAT  FIXED(F1.0,X,F2.0)
8  NPAR TESTS    K-S = DV BY IV(1,2)
9  FINISH
10 !EOJ

```

Table 40

"Data" file entitled KOLG02DAT

```

1      1 05
2      1 08
3      1 09
4      1 06
5      1 07
6      1 06
7      1 05
8      1 11
9      1 08
10     1 09
11     2 15
12     2 21
13     2 12
14     2 09
15     2 14
16     2 15
17     2 17
18     2 18
19     2 09
20     2 10

```

Table 41

KOLMOGOROV-SMIRNOV 2-SAMPLE TEST

DV
BY IV

WARNING - DUE TO SMALL SAMPLE SIZE,

=	1	=	2
	10		10

K-S Z	2-TAILED P
1.565	.015

PROBABILITY TABLES SHOULD BE CONSULTED

MAX(ABS DIFF)	MAX(+ DIFF)	MAX(- DIFF)
.7000	.7000	.0000

Categories

4-6
7-9
10-12
13-15
16-18
19-21
22-24
25-27
28-30

The Seashore rhythm subtest has thirty items. Note that the categories are set up arbitrarily. It is wise to use as many categories as possible.

Categories

	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30
MR - 40 IQ	4	9	10	10	10	10	10	10	10
MR - 60 IQ	0	2	4	7	9	10	10	10	10
Difference	4	7	6	3	1	0	0	0	0

Maximum Difference (D) = 7

The maximum difference was observed in the category (7-9) where the difference equals 7.

N equals the number of subjects in each group, where $n_1 = n_2 = 10$.

Note: N does not equal $n_1 + n_2$ (p .01).

Methodology

To compute the Kolmogorov-Smirnoff, the researcher first must randomly select two independent samples. In order to establish the cumulative frequencies, the researcher must establish the intervals which permit the direct comparison of the two samples. As the number

of intervals increases, the greater the amount of data is used.

The method of determining the maximum D is to note the largest difference between the two samples at any of the established intervals. The significance of the observed D is determined by comparing the value of D with a Kolmogorov distribution table. If the observed value of the difference D is larger than the table value, then the observed D is significant, therefore we have observed a significant difference between the two samples.

Example

A music therapist working with hyperactive children in the public school system sought to determine if there were any differences in the scores of male and female clients on an aural perception test. The researcher was interested in determining whether the groups differed.

<u>Scores</u>	
<u>Males</u>	<u>Females</u>
17	21
15	20
25	26
9	28
15	15
11	16
8	15
16	16
24	17
20	22

Categories

1-5
6-10
11-15
16-20
21-25
26-30

Categories

	1-5	6-10	11-15	16-20	21-25	26-30
Males	0	0	5	8	10	10
Females	0	0	2	6	8	10
Difference	0	2	3*	2	2	0

Number = $n_1 = n_2 = 10$, $p > .05$

*Maximum D = 3

The observed MAXIMUM DIFFERENCE of 3 is not significant at the a priori established .05 level of confidence.

In summary, the Kolmogorov-Smirnoff is suitable for comparing two independent groups when using ordinal data which is continuously distributed (fractions are admissible). It is also at least as easy to compute as the chi square.

Mann-Whitney U (ordinal)

The Wilcoxon Mann-Whitney U test was first devised by Wilcoxon in 1945 and later modified by Mann and Whitney in 1947. Most sources

indicate that the U-test is a suitable alternative to the t-test for independent samples. However, unlike the t-test, Mann-Whitney U requires only ordinal data, while the t-test requires at least interval data and possesses a number of other assumptions.

Many researchers cite the use of the U-test instead of the t-test when the assumptions underlying the t-test are violated. Still others refrain from using the U-test fearing that it is a weak alternative to the t-test. Boneau (1962) in his article, "A Comparison of the Power of the U and t-test," examined both tests according to homogeneity and heterogeneity of variance of normal distributions, and non-normal distributions. The results of this study indicated that the t-test is no less robust with minor violations of the assumptions than U, and that use of U should not be avoided on the assumption that it is less powerful than t.²²⁰

The Mann-Whitney U is based on a system of ranking data, that is, the actual raw scores are ranked 1 to N. The premise surrounding the Mann-Whitney U for two independent samples is that the two samples are drawn from different populations. The null hypothesis (H_0) states that there are no differences between the two samples.

²²⁰ C. Alan Boneau, "A Comparison of the Power of the U and t-tests," Readings in Statistics (Massachusetts: Addison-Wesley Publishing Co., 1970), p. 172.

The hypothesis is tested by the formula,

$$U = N_1 N_2 + \frac{N_1 (N_1 + 1)}{2} - R_1$$

where N_1 = the number of scores in sample one, N_2 = the number of scores in sample two, R_1 = the total of the ranks in the small sample, and R_2 = the total of the ranks in the larger distribution. Two steps are required: (1) rank the scores (1 = lowest; n = highest) and (2) sum the ranks.

Example

A researcher wished to judge the effectiveness of a behavior modification program by comparing the total number of tokens each client received in certain weeks from two different cottages. Since both samples were drawn from units which were identically matched, the data were as follows. These data represent the number of tokens awarded to clients in Cottage A as compared to Cottage B.

Number of Tokens per Cottage					
Cottage A		rank _s	Cottage B		rank _s
s ₁	10	5.5	s ₇	10	5.5
s ₂	12	8	s ₈	12	8
s ₃	9	4	s ₉	15	12
s ₄	8	3	s ₁₀	17	13
s ₅	7	2	s ₁₁	12	8
s ₆	6	$\frac{1}{23.5}$	s ₁₂	13	10
			s ₁₃	14	$\frac{11}{67.5}$

Table 42

196

"Run" file entitled MANNURUN.

```

1  !JOB TONY/. .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      MANN-WHITNEY U TEST
4  VARIABLE LIST IV,DV
5  INPUT MEDIUM DISC(MANNUDAT)
6  N OF CASES    13
7  INPUT FORMAT  FIXED(F1.0,X,F2.0)
8  NPAR TESTS    M-W = DV BY IV(1,2)
9  FINISH
10 !EOJ

```

Table 43

"Data" file entitled MANNUDAT.

1	1	10
2	1	12
3	1	09
4	1	08
5	1	07
6	1	06
7	2	10
8	2	12
9	2	15
10	2	17
11	2	12
12	2	13
13	2	14

Note that there are thirteen cases. Column two gives the group membership codes, and column three the raw data.

Table 44

MANN-WHITNEY U TEST

DV BY IV					
IV	=	1	IV	=	2
MEAN RANK		NUMBER	MEAN RANK		NUMBER U*
3.92		6	9.64		7 2.5
EXACT P		2	2-TAILED P		
.000		-2.661	.008		

$$U_2 = (6)(7) + \frac{7(7+1)}{2} - 67.5$$

$$= 42 + 28 - 67.5$$

$$U = 2.5 ; p = .002$$

$$*U_1 = n_a n_b - U_2$$

$$= 42 - 2.5$$

$$= 39.5$$

*Since the formula could be used with either sample:

$$U = n_a n_b + \frac{n_a (n_a + 1)}{2} - R_a$$

or

$$U = n_a n_b + \frac{n_b (n_b + 1)}{2} - R_b$$

it is necessary to compute both values, as most tables are computed on the smaller of the two values.

As the size of the sample grows (where n_b - the larger group exceeds 20), U begins to approach the normal distribution. It then becomes necessary to compute a z score.

$$z = \frac{U - (n_a n_b / 2)}{\sqrt{\frac{n_a n_b (n_a + n_b + 1)}{12^*}}}$$

$$z = \frac{39.5 - \frac{((6)(7))}{2}}{\frac{(6)(7)(6+7+1)}{12}}$$

$$z = \frac{18.5}{\frac{(42)(.4)}{12}}$$

$$z = \frac{18.5}{7}$$

$$z = 2.64$$

To determine the probability for the two-tailed value, divide the one-tailed value by 2. This yields the critical two-tailed z, then go to the z table and determine the probability.

Some tables require no further computation, while others require that you locate the number under the normal curve that corresponds to the observed z-value. To compute the two-tailed value, for example .4767 for a z-value of 1.99, subtract this value from .5000. Thus, the area corresponds to a z-value equalling 1.99 equals .023, hence the probability (p) < .023, that a significant difference exists

between normal and learning disabled children in regards to visual pattern recognition.

Tied scores are handled by averaging the ranks for each tie. For example, if ten scores are ranked, the highest rank must be ten (10) or thirty-five (35) if there are thirty-five scores. Observe the following example.

<u>Subjects</u>	<u>Scores</u>	<u>Ranks</u>
S ₁	5	2.5
S ₂	4	1
S ₃	10	5
S ₄	5	2.5
S ₅	6	4

The ranks of 2 and 3 are added and divided by the number of scores which are identical--in this case ranks 2 and 3 ($2 + 3 = 5/2 = 2.5$).

Summary

The tests presented in this unit are appropriate for use with data divided into two independent groups. The chi square is suitable for use with at least nominal data, while the Kolmogorov-Smirnoff and Mann-Whitney U are useful with ordinal data. Sources cited in this unit recommend the Mann-Whitney U as a viable alternative to the t-test for independent samples.

Unit 9

The Wilcoxon Matched Pairs Sign Rank Test and the McNemar Test are statistics for use with matched samples. Variouslly called correlated, related, or dependent samples, these groups are so designated because the two groups drawn are matched with regards to some extraneous variable (sex, age, IQ, etc.), or because a pre-treatment post-treatment design has been used. The Wilcoxon Matched Pairs Sign Rank Test is the counterpart of the Mann-Whitney U for correlated groups, and also requires at least ordinal data. The McNemar Test is analogous to the chi square for independent samples, and also requires nominal data.

McNemar (nominal)

The McNemar Test for Significance of Change is a particularly useful test for evaluating "before" and "after" experiments. For example, the effects of training groups on the knowledge of music therapy by hospital administrators.

Similar to the chi square, the McNemar Test for Significance of Change is based on changes from an observed to an expected change. Given the following 2 x 2 table, the responses of the respondents are placed in quadrants A (yes-before, no-after), B (no-before, no-after), C (yes-before, yes-after), and D (no-before, yes-after). These responses could have been positive versus negative, significant

versus non-significant, or any other type of dichotomous situation.

		Before	
		yes	no
After	no	A	B
	yes	C	D

As McNemar is a test of significance of change, the only cells of real interest are those that count as changes, i.e., cell A (yes-no) and D (no-yes).

Methodology

1. In order to determine if a significant change has occurred, both sets of data are first collected.
2. These data are then placed in cells corresponding to like for both data collections, unlike for both data collections, or different from one data collection to the other.
3. It is the number of different responses from the initial and subsequent data collections that is computed.
4. The basic formula is:

$$\chi^2 = \frac{(A - D)^2}{A + D}$$

where A is the initial positive response (yes) and subsequent response negative (no) and D equals initial response negative and subsequent response positive.

5. The researcher counts the number of responses in the changed response categories.

6. The McNemar test yields an approximation of the chi square distribution, with degrees of freedom = 1.

7. When data are not continuous (weight, height) but discrete categories (yes, no), Siegel (1962) recommends the following formula with the correction for continuity

$$\chi^2 = \frac{(|A - D| - 1)^2}{A + D}$$

where χ^2 equals the absolute value of cell D minus cell A (absolute means that the positive value is taken regardless of which value is larger) minus 1, quantity squared, and divided by the sum of cell A plus cell D.

Example

One hundred freshmen music students at a suburban university were asked their opinions of group psychotherapy. Following their initial polling, the students were enrolled in the course Introduction to Mental Health. At the end of the semester, the students were again polled. The results were as follows: 50 responded positively to the questionnaire initially, but negatively after the course. Ten

responded negatively for both pollings; ten responded positively for both pollings. Finally, 30 students responded negatively initially.

		Before Course	
		yes	no
After Course	yes	A 50	B 10
	no	C 10	D 30

$$\chi^2 = \frac{(|A - D| - 1)^2}{A + D}$$

$$\chi^2 = \frac{(50 - 30 - 1)^2}{50 + 30}$$

$$\chi^2 = 4.51^*$$

with df = 1
*p < .05

Other uses of the McNemar could be the determination of changed scores from pre-test to post-test scores as compared to the median after a training period.

"Run" file entitled FREEFIELD.

```

1  !JOB TONY/ .DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      MCNEMAR SAMPLE PROBLEM
4  VARIABLE LIST PRE,POST,NUMBER
5  INPUT FORMAT  FREEFIELD
6  N OF CASES    4
7  WEIGHT        NUMBER
8  NPAR TESTS    MCNEMAR = PRE POST
9  READ INPUT DATA
10 1 -1 50 1 1 10 -1 -1 10 -1 1 30
11 FINISH
12 !EOJ

```

Note that the raw data appears in line ten.

Table 46

MCNEMAR TEST

PRE
WITH POST

		POST		
		1	-1	
PRE	1	-----1-----	-----1	
	-1	1 30 1	10 1	
		1-----1-----	-----1	
	1	1 10 1	50 1	
		1-----1-----	-----1	

CASES 100

CHI-SQR 4.512

2-TAILED P .034

Wilcoxon Matched Pairs Sign Rank
Test (ordinal)

The Wilcoxon was previously mentioned as the counterpart of the Mann-Whitney U, with the exception that the Wilcoxon is suited for correlated samples. The Wilcoxon is a non-parametric alternative to the t-test for correlated samples.

Methodology

1. To compute the Wilcoxon Matched Pairs Sign Rank Test, it is necessary that the data be arranged in pairs, that is, two scores per subject. In this test, N equals the number of pairs.

For example, subjects participating in a social maturity study yielded the following data:

<u>Subjects</u>	<u>Pre-test</u>	<u>Post-test</u>	<u>Differences</u>
S ₁	15	20	-5
S ₂	21	22	-1
S ₃	20	19	+1
S ₄	27	30	-3
S ₅	31	33	-2
S ₆	16	18	-2
S ₇	17	9	+8
S ₈	12	11	+1
S ₉	22	20	+2
S ₁₀	25	30	-5

2. After the data are appropriately arrayed, the numerical differences between the pre-test and post-test scores are computed.

This will yield the difference or d_i . See Step 1.

3. The absolute values of the differences are then ranked.

<u>Differences</u>	<u>Ranks</u>
+8	10
-5	8.5
-5	8.5
-3	7
-2	5
+2	5
+2	5
+1	2
+1	2
-1	2

4. The ranks of the negative values represent the scores of subjects 2, 5, 5, 7, 8.5, 8.5. The ranks of the positive values represent subjects (2, 2, 5, 10).

5. The sum of the negative ranks equals 36; the sum of the positive ranks equals 19. The smaller of the two values is defined as T , which is compared to a tabled value.

6. To determine whether T is significant, consult a Wilcoxon significance table.

"Run" file entitled WILCORUN

1	!JOB TONY/	.DECUIR
2	!RUN SPSS.PUB.	SPSS
3	RUN NAME	WILCOXON MPSRT SAMPLE PROBLEM
4	VARIABLE LIST	PRE,POST
5	INPUT MEDIUM	DISC(WILCODAT)
6	N OF CASES	10
7	INPUT FORMAT	FIXED(F2.0,X,F2.0)
8	NPAR TESTS	WILCOXON = PRE WITH POST
9	FINISH	
10	!EOJ	

Table 48

"Data" file entitled WILCORUN

1	15	20
2	21	22
3	20	19
4	27	30
5	31	33
6	16	18
7	17	09
8	12	11
9	22	20
10	25	30

Note that the data are paired and numbered. Also, notice the use of the zero with the one digit numbered.

Table 49

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST

 PRE
WITH POST

	4 -RANKS	6 +RANKS	
CASES	MEAN	MEAN	Z
10	4.75	6.00	-.866

 2-TAILED P
.386

Example

Field studies attempt to determine the ability of individuals to perceive objects both within their normal fields and outside of their normal fields. To this end, a researcher interested in determining whether his subjects' ability to perceive objects in various perceptual fields could be effected by a specially designed music therapy activities, administered a figure-ground test to his clients before and after the program.

<u>Before</u>	<u>After</u>	<u>Differences (di)</u>	<u>Ranks</u>
22	23	-3	1
15	20	-5	3.5
17	21	-4	2
18	25	-7	5.5
19	26	-7	5.5
17	22	-5	3.5

Negative differences = 20

Positive differences = 0 = T (the smaller of the two values)

Number of pairs = 6 = N

$p < .05$

Summary

The tests discussed in this section are appropriate to use with samples described variously as equivalent, related, correlated, or dependent samples. The McNemar test for significance of change

(nominal) and the Wilcoxon matched-pairs signed-rank test (ordinal) are particularly suitable for comparing pre-test and post-test scores.

Unit 10

Non-Parametric Statistics for More than Two Groups

In earlier units the discussions have been concerned with tests of goodness-of-fit and comparisons of two groups. Researchers are frequently interested in studying variables across groups of three or more. The advantages of studying three or more groups simultaneously is that the tedium of comparing each group to the other, is avoided, and the researcher is able to examine variables in a more natural state, and it frequently provides linear information about the independent variable.

Statistical tests to be reviewed in this unit are suited for independent samples, chi square (nominal) and Kruskal-Wallis One-Way Analysis of Variance (ordinal), and matched samples, the Friedman Two-Way Analysis of Variance.

Chi Square (nominal)

Here, too, chi square is based on observing differences between a predicted response and an actual or observed response. The χ^2 is suited for nominal data. The data are arrayed in a grid of rows and columns with each cell contributing to the overall size of χ^2 .

Methodology

The computation of χ^2 requires that the response be analyzed in a cellular fashion. For example, a researcher might be interested in

studying the socioeconomic make-up of students in his department. The students sampled were juniors, seniors, and graduate students. Their socioeconomic status was broken down into three categories: \$10,000, \$25,000, and \$50,000. The resulting contingency table contains nine (3 x 3) independent cells. As with other chi square tests, it is necessary that the cells be independent of each other. In this example, independence is assumed because a person cannot be both a junior and a senior, or simultaneously in two different socioeconomic categories.

Classifications

<u>Socioeconomic Status</u>	<u>Jr's</u>	<u>Sr's</u>	<u>Grad's</u>	<u>Totals</u>
	10.9	10.4	11.7	
\$10,000	10	11	12	33
	8.2	7.9	8.9	
\$25,000	8	8	9	25
	5.9	5.7	6.4	
\$50,000	7	5	6	18
	25	24	27	76

E_x = Expected Frequency

χ^2 equals the sum of all the actual (observed) responses minus the predicted response, squared, divided by the predicted response. The expected frequencies are determined by multiplying the appropriate rows total by the corresponding column total and dividing by the total N of the sample. Observe the following example:

Table 50

"Run" file entitled CHIS2RUN

```

1  !JOB TONY/ ..DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      CHI SQUARE 3 BY 3 PROBLEM
4  VARIABLE LIST SES,CLASS
5  INPUT MEDIUM DISC(CHIS2DAT)
6  N OF CASES    76
7  INPUT FORMAT  FIXED(2F1.0)
8  VALUE LABELS  SES (1)10K (2)25K (3)50K/
9                CLASS (1)JR (2)SR (3)GRAD
10 CROSSTABS      TABLES = SES BY CLASS
11 STATISTICS     ALL
12 FINISH
13 !EOJ

```

Table 51
 "Data" file entitled CHIS2DAT

1	11	26	12	50	13
2	11	27	12	51	13
3	11	28	12	52	13
4	11	29	12	53	13
5	11	30	12	54	13
6	11	31	12	55	13
7	11	32	12	56	13
8	11	33	12	57	13
9	11	34	12	58	13
10	11	35	12	59	13
11	21	36	12	60	13
12	21	37	22	61	13
13	21	38	22	62	23
14	21	39	22	63	23
15	21	40	22	64	23
16	21	41	22	65	23
17	21	42	22	66	23
18	21	43	22	67	23
19	31	44	22	68	23
20	31	45	32	69	23
21	31	46	32	70	23
22	31	47	32	71	33
23	31	48	32	72	33
24	31	49	32	73	33
25	31			74	33
				75	33
				76	33

Note that there are seventy-six responses. SPSS will number each response in most instances. The numbers to the right are the actual responses.

Table 52
CHI SQUARE 3 BY 3 PROBLEM

		CLASS					
		COUNT	I				
ROW	PCT	IJR		SR		GRAD	ROW
COL	PCT	I					TOTAL
TOT	PCT	I	1.1	2.1	3.1		
SES	1.	I	10	I	11	I	33
		I	30.3	I	33.3	I	43.4
		I	40.0	I	45.8	I	
		I	13.2	I	14.5	I	
10K	2.	I	8	I	8	I	25
		I	32.0	I	32.0	I	32.9
		I	32.0	I	33.3	I	
		I	10.5	I	10.5	I	
25K	3.	I	7	I	5	I	18
		I	38.9	I	27.8	I	23.7
		I	28.0	I	20.8	I	
		I	9.2	I	6.6	I	
COLUMN			25		24		76
TOTAL			32.9		31.6		100.0

CHI SQUARE = .41847 WITH 4 DEGREES OF FREEDOM

SIGNIFICANCE = .9809

$$\begin{aligned}
 \chi^2 &= \frac{(10 - 10.9)^2}{10} + \frac{(11 - 10.4)^2}{11} + \\
 &\quad \frac{(12 - 11.7)^2}{12} + \frac{(8 - 8.2)^2}{8} + \\
 &\quad \frac{(8 - 7.9)^2}{8} + \frac{(9 - 8.9)^2}{9} + \\
 &\quad \frac{(7 - 5.9)^2}{7} + \frac{(5 - 5.7)^2}{5} + \\
 &\quad \frac{(6 - 6.4)^2}{6} \\
 \chi^2 &= .513
 \end{aligned}$$

The degrees of freedom for chi square contingency tables equals (columns - 1) x (rows - 1), or, in this example, (3 - 1) x (3 - 1) = 4. It should be cautioned that with degrees of freedom equalling 1, 20% of the cells should have frequencies of at least 5 (Cockran, 1954). When necessary to meet this requirement, adjacent categories can be combined.

Example

A researcher was interested in dividing open activity offerings into groups (1, 2, 3) representing the amounts of extroversion offered to the participant. The clients were diagnosed as athetoid, ataxic, and spastic. The groups were composed of 20 athetoids, 20 ataxics, and 20 spastics. The following contingency table was obtained.

Table 53

Contingency Table for Group Activities

Clients	Groups			Total
	I	II	III	
Athetoids	E 7 O 10	5.3 5	7.7 5	20
Ataxics	E 7 O 5	5.3 5	7.7 10	20
Spastics	E 7 O 6	5.3 6	7.7 8	20
	21	16	23	60

$$\begin{aligned}
 \chi^2 = & \frac{(10 - 7)^2}{10} + \frac{(5 - 5.3)^2}{5} + \frac{(5 - 7.7)^2}{5} + \\
 & \frac{(5 - 7)^2}{5} + \frac{(5 - 5.3)^2}{5} + \frac{(10 - 7.7)^2}{10} + \\
 & \frac{(6 - 7)^2}{6} + \frac{(6 - 5.3)^2}{6} + \frac{(8 - 7.7)^2}{8}
 \end{aligned}$$

$$\chi^2 = 3.99$$

$$\text{degrees of freedom} = (\text{columns} - 1) \times (\text{rows} - 1) = (3 - 1) \times (3 - 1) = 4$$

In this case, $\chi^2 = 3.99$, $df = 4$, not significant.

Kruskal-Wallis One-Way Analysis of Variance (ordinal)

The Kruskal-Wallis One-Way Analysis of Variance is a counter-part of the χ^2 for three or more independent samples previously discussed. Unlike the χ^2 , however, the Kruskal-Wallis is suited for at

least ordinal data; consequently, it is more powerful than χ^2 . Similarly, as the Mann-Whitney U is the non-parametric counterpart of the t-test for two independent samples, the Kruskal-Wallis is the counterpart of the One-Way Analysis of Variance, F. Also, Kruskal-Wallis uses the procedure of ranking the data similar to the Mann-Whitney U.

For example, an experimenter was interested in determining if a cerebral palsied client's exercise rate could be increased by providing background music of a tempo different from the client's normal exercise rate. The following data were achieved. The conditions were No Music, Faster Music, and pre-Matched Music to the patient's daily exercise rate (Matched Music).

<u>No Music</u>	<u>rank</u>	<u>Faster Music</u>	<u>rank</u>	<u>Matched Music</u>	<u>rank</u>
Day 1 93	6	Day 2 101	16	Day 3 98	10.5
Day 6 89	5	Day 4 103	18	Day 5 99	13
Day 8 94	7	Day 9 99	13	Day 7 100	15
Day 10 86	3	Day 11 88	4	Day 12 97	8.5
Day 15 85	2	Day 13 102	17	Day 14 98	10.5
Day 17 82	<u>1</u>	Day 18 97	<u>8.5</u>	Day 16 99	<u>13</u>
	24		76.5		70.5

The Kruskal-Wallis is calculated by the following formula:

$$H = \frac{12}{N(N+1)} \sum \frac{R^2}{n} - 3(N+1)$$

where 12 = constant

N = total number of observations

R = sum of the ranks in each group

n = number in each group

$$\begin{aligned}
H &= \frac{12}{18(18+1)} \frac{24^2}{6} + \frac{76.5^2}{6} + \frac{70.5^2}{6} - 3(18+1) \\
&= .035(1899.74) - 57 \\
&= 66.49 - 57 \\
&= 9.49
\end{aligned}$$

Methodology

1. In order to compute H, the scores are arrayed in their appropriate groups.
2. The scores are then ranked from lowest to highest, where 1 equals the lowest.
3. The ranks of each group (R) are then summed, squared, and divided by the number of scores in the group (n).
4. When the number of subjects in any group is greater than 5, H is distributed similarly to chi square and the results of H should be evaluated from a chi square probability table.
5. Tied scores require the computation of a correction formula:

$$H_c = \frac{H}{1 - \frac{(t^3 - t)}{N^3 - N}}$$

where t = the number of tied ranks

In the above example, Day 12 and Day 18 are tied, here t = 2; for Day 3 and Day 14 t = 2; Day 5, Day 9, and Day 16, t = 3. Therefore,

"Run" file entitled KRUSKRUN.

```

1  !JOB TONY/ ...DECUIR
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      KRUSKAL-WALLIS SAMPLE PROBLEM
4  VARIABLE LIST IV,DV
5  INPUT MEDIUM DISC(KRUSKDAT)
6  N OF CASES    18
7  INPUT FORMAT  FIXED(F1.0,X,F3.0)
8  NPAR TESTS    K-W = DV BY IV(1,3)
9  FINISH
10 !EQJ

```

Table 55

"Data" file entitled KRUSKDAT.

```

      1      1 093
      2      1 089
      3      1 094
      4      1 086
      5      1 085
      6      1 082
      7      2 101
      8      2 103
      9      2 099
     10      2 088
     11      2 102
     12      2 097
     13      3 098
     14      3 099
     15      3 100
     16      3 097
     17      3 098
     18      3 099

```

Note the eighteen numbered cases in in KRUSKDAT; the single digit center column is the group code and the last column is the raw data.

$$t^3 - t = (2^3 - 2) + (2^3 - 2) + (3^3 - 3)$$

$$t^3 - t = 6 + 6 + 24 = 36$$

$$\begin{aligned} H_c &= \frac{9.49}{1 - \frac{36}{18^3 - 18}} \\ &= \frac{9.49}{1 - \frac{36}{5814}} \\ &= \frac{9.49}{1 - .006} \\ &= \frac{9.49}{.994} \\ &= 9.55 \end{aligned}$$

The final non-parametric device to be reviewed in this unit is the Friedman two-way analysis of variance. The Friedman (X^2_r) is suitable for determining whether three or more correlated samples were drawn from the same population.

The Friedman (X^2_r) is particularly useful for testing the same subject under a number of different conditions. For example, subjects may be analyzed according to three or more different teaching approaches. Three or more different matched groups might be analyzed according to their position. The Friedman is called two-way because it takes into account the row value as well as the column value.

Methodology

In order to determine whether the groups were drawn from the same population, the following formula is used:

$$X_r^2 = \frac{12}{Nk(k+1)} \sum_{j=1}^k [(R_j^2) - 3N] (k+1)$$

where

N = total number of subjects

k = number of measures, treatments or columns

R_j = sum of the ranks in each column

= sum of all

For example, the following raw data are arranged for the computation of X_r^2 .

1. Scores are again ranked from lowest to highest across the rows. (This differs from the other rankings.)

Table 57
Friedman Data

Raw Data				Ranked Data		
Treatments				Treatments		
	I	II	III	I	II	III
S ₁	52	48	70	2	1	3
S ₂	70	81	45	2	3	1
S ₃	53	55	57	1	2	3
S ₄	52	49	42	3	2	1
S ₅	45	40	31	3	2	1
S ₆	49	40	36	3	2	1
				R ₁ =14	R ₂ =12	R ₃ =10

FRIEDMAN TWO-WAY ANOVA

```

1  !JOB TONY/ .DECU1R
2  !RUN SPSS.PUB.SPSS
3  RUN NAME      FRIEDMAN SAMPLE PROBLEM
4  VARIABLE LIST TREAT1,TREAT2,TREAT3
5  INPUT MEDIUM DISC(FRIEDDAT)
6  N OF CASES    6
7  INPUT FORMAT  FIXED(3F2.0)
8  NPAR TESTS    FRIEDMAN = TREAT1 TREAT2 TREAT3
9  FINISH
10 !EOJ

```

"Run" file FRIEDRUN.

Table 59

"Data" file entitled FRIEDDAT; results of Friedman analysis.

```

1  524870
2  708145
3  535557
4  524942
5  454031
6  494036

```

```

TREAT1
TREAT2
TREAT3

```

	TREAT1	TREAT2	TREAT3
MEAN RANKS	2.33	2.00	1.67

CASES	CHI-SQUARE	D.F.	SIGNIFICANCE
6	1.333	2	.513

2. Sum the columns of the ranked scores to realize R_1 , R_2 , and R_3 .

3. Square each of the R_j 's, here $14^2 + 12^2 + 10^2$. The sum of each of the squares equal 440.

4. Substitutions into the formula appears as follows:

$$X_r^2 = \frac{12}{(6)(3)(3+1)} [14^2 + 12^2 + 10^2] - 3(6)(3-1)$$

$$X_r^2 = \frac{12}{72} [196 + 144 + 100] - 72$$

$$X_r^2 = (.17)(440) - 72$$

$$*X_r^2 = 74.8 - 72 = 2.8$$

degrees of freedom equals $k - 1 = 3 - 1 = 2$

*Note that in arithmetic, multiplication precedes addition and subtraction.

Summary

The statistics reviewed in this unit are appropriate for determining whether three or more dependent or independent samples were drawn from the same population. The chi square and Kruskal-Wallis tests are useful with independent samples where the data are nominal and ordinal, respectively. The Friedman two-way is useful for ordinal data and for a dependent or correlated sample.

As this unit concludes the review of non-parametric statistics, it is necessary to review some of the conditions warranting the use

of these devices.

1. distribution-free, no assumptions about population
2. nominal and ordinal scale of measurement are adequate
3. amenable to non-numeric data, and small samples
4. computational simplicity

One major use of non-parametric statistics has been to substitute them for the more powerful parametric statistics when the parametric assumptions could not be met.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to develop a course in experimental design and statistics for graduate music therapy students. The Loyola University Music Therapy Department was established in 1957 and the master's curriculum was added in 1967. Currently, there are seven core courses in the graduate curriculum. Of these seven core courses, the graduate student is required to complete three courses in experimental design and statistics, all of which are completed outside the Department. In addition, the student must complete four experimental research projects, one of which is a thesis.

The primary purpose of this research was to develop an advanced statistics course which would address specific research problems in music therapy. In the spring of 1979, two independent research projects were undertaken which examined the unpublished research papers of music therapy students from 1967 to 1979. Both studies found that the primary deficiencies of these studies were inadequately conceived (1) methodologies and (2) gross errors in research design. As an addendum to the development of this course, statistical course offerings of the sixty-four music therapy departments approved by the National

Association for Music Therapy were examined. Respondents generally felt that one semester of statistics adequately prepared the graduate and bachelor's level student to read and interpret research as well as to carry out their own research after graduation. It is interesting to note that Janet Gilbert, Editor of the Journal of Music Therapy, reported that deficient experimental designs and inappropriate statistical usage were the primary reasons for the rejection of manuscripts.

The literature reviewed in conjunction with this report covered the thirty-year existence of music therapy as a formal profession. The rationale for this review was the need to re-examine the ideas and beliefs held by the founders of the Association concerning the importance of research to the development of music therapy as a profession. These beliefs first appeared in the 1951 Music Therapy Yearbook. They were:

1. To encourage and report research projects
2. To maintain a close working alliance with medical personnel
3. To maintain a close interest in the actual application of music in treatment programs in either a hospital or non-hospital setting
4. To offer assistance in maintaining and developing standards of training for hospital musicians and music therapists
5. To offer aid in the establishment of music therapy positions where budget and personnel allocations permit
6. To aid in the distribution of helpful information pertaining

to music therapy.²²¹

Also covered in the review of the literature were clinical and experimental research papers in the following disability areas: physical disability, gerontology, drug abuse, penology, adult and childhood mental illness and mental retardation. This review of the literature is intended to serve as a chronology of the state of the research base in music therapy. It is intended specifically to point out areas where additional research is needed as well as where replication is warranted.

There are fourteen review and core units contained in the course. The four review units present research terminology, an introduction to the computer terminal, the t-test, and the completely randomized design, all of which should have been taught in previous statistics and research courses. The ten course units present various types of analyses of variance and covariance, multiple correlation and regression, discriminant function analysis, and non-parametric statistics.

Conclusions

Most of the examples cited in this report were taken from the research files of the Music Therapy Department at Loyola University. They are intended both to serve as clear examples for which the methodologies are appropriate and to aid in the heuristic development of

²²¹Music Therapy. 1951, Book of Proceedings of the National Association for Music Therapy (Chicago, Ill.: 1950), p. v.

the graduate student. The intention was, in the development of the course, to provide as many and as varied examples as possible so that the student might have a data base to draw from when starting clinical work.

Recommendations

The course (called Music Therapy VIII) was first taught in the Fall of 1980. At that time it became apparent that the sequence of review and course units needed to be re-aligned. This re-alignment involved orienting the student to the computer terminal earlier in the semester. It also was determined at the termination of the course that non-parametric statistics were best taught after parametric statistics. Both changes allowed the students to use the computer terminal through the parametric units (at that time non-parametric statistics were not computable by a statistical package on the computer). The re-alignment was further justified by the students who as a group reported that although easier to compute, the non-parametric devices tended to be tedious and time consuming. The students who have completed the course, as well as those currently enrolled, agree that examples from the literature are an aid to understanding experimental research and statistics.

BIBLIOGRAPHY

- Aldridge, C. "Choice of Rhythm Instruments and the Use of Rhythm Band Scores by TMR Adult Females." Mental Retardation (April, 1979): 89-90.
- Allen, D. M. "Music Therapy with Geriatric Patients." British Journal of Music Therapy 8 (Autumn, 1977): 2-6.
- Allen, M. "Educating Through Music - An Innovative Program for Hearing Impaired Children." Volta Review 77 (1975): 381-385.
- Anderson, K. E. "General Considerations: A Frame of Reference for Research." In Music Therapy 1952. Edited by Esther Gilliland. Lawrence, Kansas: National Association for Music Therapy, 1953.
- Austin, J. "The Deaf Child." Conference Papers 1971-1976, British Society for Music Therapy.
- Bachrach, A. J. Psychological Research. 3rd ed. New York: Random House, 1972.
- Ball, T. S., and McCrady, R. E. "Automated Reinforcement of Head Posture in Two Cerebral Palsied Retarded Children." Perceptual and Motor Skills 40 (April, 1975): 619-622.
- Band, E. "Working with the Power of the Sound Experience in Early Development and Therapy." Journal, Canadian Association for Music Therapy 6 (1978): 15-20.

- Bellamy, T., and Sontag, E. "Use of Group Contingent Music to Increase Assembly Line Production Rates of Retarded Students in a Simulated Sheltered Workshop." Journal of Music Therapy 10 (Fall, 1973): 125-136.
- Bennis, D. "The Use of Music as a Therapy in the Special Education Classroom." Journal of Music Therapy 6 (Spring, 1969): 15-18.
- Berel, M., Dider, L., and Orgel, M. "Music as a Facilitator for Visual Motor Sequencing Tasks in Children with Cerebral Palsy." Developmental Medicine and Child Neurology 13 (1971): 335-342.
- Birkenshaw, L. "Consider the Lowly Kazoo." Volta Review 77 (October, 1975): 440-444.
- Bitcon, C., and Ball, T. "Generalized Imitation and Orff-Schulwerk." Mental Retardation 12 (June, 1974): 36-39.
- Bixler, J. "Musical Aptitude in the Educable Mentally Retarded Child." Journal of Music Therapy 5 (June, 1968): 41-43.
- _____. "Operetta Production with Physically Handicapped Children." In Music Therapy 1960. Edited by E. H. Schneider. Lawrence, Kansas. National Association for Music Therapy, 1961.
- Bonny, H. L. "Preferred Loudness of Recorded Music of Hospitalized Psychiatric Patients and Hospital Employees." Journal of Music Therapy 5 (Spring, 1968): 44-52.
- _____, and Pahnke, W. N. "The Use of Music in Psychedelic (LSD) Psychotherapy." Journal of Music Therapy 9 (Summer, 1972): 64-87.

- Boxberger, R. "Historical Bases for the Use of Music in Therapy." In Music Therapy 1961. Edited by E. H. Schneider. Lawrence, Kansas: National Association for Music Therapy, 1962.
- _____. "History of the National Association for Music Therapy, Inc." In Music Therapy 1962. Edited by E. H. Schneider. Lawrence, Kansas: National Association for Music Therapy, 1963.
- Braswell, C., Maranto, C., and Decuir, A. "A Survey of Clinical Practice in Music Therapy, Part I: The Institutions in Which Music Therapists Work and Personal Data." Journal of Music Therapy 16 (Spring, 1979): 2-16.
- _____. "Education and Research in Music Therapy." In Music Therapy 1960. Edited by E. H. Schneider. Lawrence, Kansas: National Association for Music Therapy, 1961.
- _____. "The Future of Psychiatric Music Therapy." In Music Therapy 1961. Edited by E. H. Schneider. Lawrence, Kansas: National Association for Music Therapy, 1962.
- _____, Buttram, J. B., Goldstein, H. K., Ott, W. H., and Schoenberger, L. "The Influence of Music Therapy on Vocational Potential." Journal of Music Therapy 7 (Spring, 1970): 28-38.
- Breidenthal, M. "The Music Therapist as Special Educator in the Public Schools." In Music Therapy 1958. Edited by E. H. Schneider. Lawrence, Kansas: National Association for Music Therapy, 1959.
- Brown, M. E., and Seliger, M. "A Nontherapeutic Device for Approaching Therapy in an Institutional Setting." Journal of

- Group Psychotherapy 19 (January, 1969): 88-95.
- Brown, C. "Assessment of the Effects of Music Therapy in a Geriatric Hospital." Proceedings, First National Conference Australian Music Therapy Association, (August, 1975): 2-5.
- Bruner-Orne, M. "The Use of Handbells in Music Therapy in a Hospital Setting." In Music Therapy 1955. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1956.
- Brunton, K. M. "Music with Blind Children." Conference Papers British Society for Music Therapy, 1962-67.
- Bullen, D. "Effects of Music Activities on Groups with Special Needs in the Comox Valley." The Journal, Canadian Music Therapy Association 1 (Winter, 1976): 7-8.
- Campbell, D. T., and Stanley, J. C. Experimental and Quasi-Experimental Designs for Research. Chicago: Rand McNally and Company, 1963.
- Capek, A. "Music and the Blind Child." Proceedings of the Second National Conference of the Australian Music Therapy Association, 1976.
- Carroccio, D. F., and Quattlebaum, L. F. "An Elementary Technique for Manipulation of Participation in Ward Dances at a Neuropsychiatric Hospital." Journal of Music Therapy 6 (Winter, 1969): 108-109.
- Cartwright, J., and Huckaby, G. "Intensive Preschool Language Program." Journal of Music Therapy 9 (Fall, 1972): 137-146.

- Cassidy, M. D. "The Influence of a Music Therapy Activity Upon Peer Acceptance, Group Cohesiveness, and Interpersonal Relationships of Adult Psychiatric Patients." Journal of Music Therapy 13 (Summer, 1976): 66-75.
- Christenberry, E. E. "The Use of Music Therapy with Burn Patients." Journal of Music Therapy 16 (Fall, 1979): 138-148.
- Cook, M., and Freethy, M. "The Use of Music as a Positive Reinforcer to Eliminate Complaining Behavior." Journal of Music Therapy 10 (Winter, 1973): 213-216.
- Cotter, V. W. "Effects of Music on Performance of Manual Tasks with Retarded Adolescent Females." American Journal of Mental Deficiency 76 (September, 1971): 242-248.
- Crocker, D. B. "Music as a Projective Technique." In Music Therapy 1955. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1956.
- Crockford, C. "Making the Most of Rhythm and Song: An Invitation to the Withdrawn Child." Journal, Canadian Association for Music Therapy 5 (Summer, 1977): 7-8.
- Darrow, A. "The Beat Reproduction Response of Subjects with Normal and Impaired Hearing: An Empirical Comparison." Journal of Music Therapy 16 (Summer, 1979): 91-98.
- de Aisenwaser, V. "Music Therapy with a Mentally Deficient Girl." British Journal of Music Therapy 6 (Summer, 1975): 2-8.
- Decuir, A. "Analysis of Fifteen Unpublished Research Reports in

- Music Therapy." New Orleans, 1979. (Mimeographed.)
- _____. "A Survey of Statistical Course Offerings in Music Therapy." Paper presented at the 31st Annual Conference of the National Association for Music Therapy, Minneapolis, Minnesota, 4 November 1980.
- _____. "Vocal Responses of Mentally Retarded Subjects to Four Musical Stimuli." Journal of Music Therapy 12 (Spring, 1975): 40-43.
- Diephouse, D. A. "The Evolution of a Music Therapy Program for Children." Psychiatric Quarterly Supplement 38 (1964): 119-126.
- Dileo, C. L. "The Relationship of Diagnostic and Social Factors to the Singing Ranges of Institutionalized Mentally Retarded Persons." Journal of Music Therapy 13 (Spring, 1976): 17-27.
- Dileo, C. L. "The Use of a Token Economy Program with Mentally Retarded Persons in a Music Therapy Setting." Journal of Music Therapy 12 (Fall, 1975): 153-160.
- Ditson, R. "A Study of the Effects of Moderate Background Music on the Behavior of Cerebral Palsied Children." Bulletin of the National Association for Music Therapy 10 (September, 1961): 6.
- Dorow, L. "Conditioning Music and Approval as New Reinforcers for Imitative Behavior with the Severely Retarded." Journal of Music Therapy 12 (Spring, 1975): 30-39.
- Eagle, C. T. "Music and LSD: An Empirical Study." Journal of Music Therapy 9 (Spring, 1972): 23-36.

- Eisenstein, S. R. "Effects of Contingent Guitar Lessons on Reading Behavior." Journal of Music Therapy 11 (Fall, 1974): 138-146.
- Explore the 80's at Loyola, Loyola University Bulletin, vol. LXVII, no. 1. New Orleans: Loyola University Bulletin, 1980.
- Fahey, J. D., and Birkenshaw, L. "Bypassing the Ear: The Perception of Music by Feeling and Touch." Music Educators Journal 58 (August, 1972): 44-49.
- Ficken, T. "The Use of Songwriting in a Psychiatric Setting." Journal of Music Therapy 14 (Winter, 1976): 163-172.
- Frankel, N. B. "The Autistic Psychotic Child: the Use of Music Therapy." Bulletin, Children's Hospital 2 (January, 1977): 14-16.
- Fultz, A. F. "Research Literature." In Music Therapy 1952. Edited by Esther G. Gilliland. Lawrence, Kansas: National Association for Music Therapy, 1954.
- _____. "The NAMT Long Range Design for Music Therapy Research." In Music Therapy 1953. Edited by Mariana Bing. Lawrence, Kansas: National Association for Music Therapy, 1954.
- Galloway, H. F. "Stuttering and the Myth of Therapeutic Singing." Journal of Music Therapy 11 (Winter, 1976): 220-227.
- _____, and Bean, M. F. "The Effects of Action Songs on the Development of Body-Image and Body-Part Identification in Hearing Impaired Preschool Children." Journal of Music Therapy 11 (Fall, 1974): 125-134.
- Gaston, E. T. "Introductory Remarks, 'Research and Music Therapy'." In Music Therapy 1956. Lawrence, Kansas: National Association

- for Music Therapy, 1957.
- _____, ed. "The Development of a Research Program." In Music Therapy 1954. Lawrence, Kansas: National Association for Music Therapy, 1955.
- Gibbons, A. C. "Popular Music Preferences of Elderly People." Journal of Music Therapy 14 (Winter, 1977): 180-189.
- Gilbert, J. P. "Guidelines to Contributors." Journal of Music Therapy 17 (Summer, 1980): 46-49.
- _____. "Published Research in Music Therapy, 1973-1978: Content, Focus, and Implications for Future Research." Journal of Music Therapy 16 (Fall, 1979): 102-110.
- Goldstein, C. "Music and Creative Arts Therapy for an Autistic Child." Journal of Music Therapy 1 (Winter, 1964): 135-138.
- Goodnow, C. "The Use of Dance in Therapy with Retarded Children." Journal of Music Therapy 5 (December, 1968): 97-102.
- Gordon, B. L. "Music Therapy for Moderately and Severely Retarded School Children." The Journal, Canadian Association for Music Therapy 6 (1978): 21-24.
- Gordon, E. "The Use of the Musical Aptitude Profile with Exceptional Children." Journal of Music Therapy 5 (June, 1968): 37-40.
- Goward, B. "Stimulating Regressed Patients." British Journal of Music Therapy 5 (Fall, 1974): 22-26.
- Graham, R. "Practical Research in Music Therapy." Journal of Music Therapy 6 (Winter, 1969): 94-97.
- Greenberg, M. "A Preliminary Report of the Effectiveness of a Pre-

- school Music Curriculum with Preschool Headstart Children."
- Council for Research in Music Education: Bulletin 29 (Summer, 1972): 13-16.
- Greene, R., Hoats, D. L., and Dibble, W. A. "Generalization of the Aversive Effects of Music Distortion." The Psychological Record 25 (Spring, 1975): 173-180.
- _____, Hoats, D. L., and Harnick, A. J. "Music Distortion: a New Technique for Behavior Modification." The Psychological Record 20 (1970): 107-109.
- Greenwald, A. M., and Salzburg, R. S. "Vocal Range Assessment of Geriatric Clients." Journal of Music Therapy 16 (Winter, 1979): 172-179.
- Grossman, H. J., ed. Manual on Terminology and Classification in Mental Retardation. Washington, D. C.: American Association on Mental Deficiency, 1973.
- Grossman, S. "An Investigation of Crocker's Music Projective Techniques for Emotionally Disturbed Children." Journal of Music Therapy 15 (Winter, 1978): 179-184.
- Groves, L. "Music Movement and Mime." Nursing Times 64 (March, 1968): 295-297.
- Hanser, S. B. "Group-Contingent Music Listening with Emotionally Disturbed Boys." Journal of Music Therapy 11 (Winter, 1974): 220-225.
- Hauck, L. P., and Martin, P. L. "Music as a Reinforcer in Patient-Controlled Duration of Time-Out." Journal of Music Therapy 7

- (Summer, 1970): 43-53.
- Healey, E. C., Mallard, III, A. R., and Adams, M. R. "Factors Contributing to the Reduction of Stuttering During Singing." Journal of Speech and Hearing Disorders 19 (September, 1976): 475-480.
- Heckel, R. V., Wiggins, S. L., and Salzberg, H. C. "The Effects of Musical Tempo in Varying Operating Speech Levels in Group Therapy." Journal of Clinical Psychology 19 (January, 1963): 129.
- Hecox, B., Levine, E., and Scott, D. "Dance in Physical Rehabilitation." Physical Therapy 58 (August, 1976): 919-924.
- Herron, C. J. "Some Effects of Instrumental Music Training on Cerebral Palsied Children." Journal of Music Therapy 7 (Summer, 1970): 55-58.
- Hollis, J. "Body-Rocking: Effects of Sound and Reinforcement." American Journal of Mental Deficiency 75 (March, 1971): 642-644.
- Holser, P., and Krantz, R. "Music Therapy in an Adult Cerebral Palsy Center." American Journal of Occupational Therapy 14 (March, 1960): 61-63.
- Huck, S. W., Cormier, W., and Bound, W. Reading Statistics and Research. New York: Harper and Row Publishers, 1974.
- Humphrey, T. "The Effect of Music Ear Training Upon the Auditory Discrimination Abilities of Trainable Mentally Retarded Adolescents." Journal of Music Therapy 17 (Summer, 1980): 70-74.
- _____. "The Use of Continuous and Contingent Background Music to Decrease Occurrences of Aggressive Behavior Among Profoundly

- Retarded Young Adults." New Orleans, 1980. (Mimeographed.)
- Isern, B. "Music in Special Education." Journal of Music Therapy 1 (December, 1964): 139-142.
- Jellison, J. A. "The Frequency and General Mode of Inquiry of Research in Music Therapy, 1952-1972." Council for Research in Music Education 35 (Winter, 1973): 1-8.
- Johnson, J., and Zinner, C. "Stimulus Fading and Schedule Learning in Generalizing and Maintaining Behaviors." Journal of Music Therapy 11 (Summer, 1974): 84-96.
- Jorgenson, H. "Effect of Contingent Preferred Music in Reducing Two Stereotyped Behaviors of a Profoundly Retarded Child." Journal of Music Therapy 8 (Winter, 1971): 139-145.
- _____. "The Use of a Contingent Music Activity to Modify Behaviors Which Interfere with Learning." Journal of Music Therapy 9 (Spring, 1974): 41-46.
- _____, and Parnell, M. "Modifying Social Behaviors of Mentally Retarded Children in Music Activities." Journal of Music Therapy 7 (Fall, 1970): 139-142.
- Josepha, Sr. M. "Therapeutic Value of Instrumental Performances for Severely Handicapped Children." Journal of Music Therapy 1 (Fall, 1964): 74-79.
- Kaplan, P. R. "A Criterion-Referenced Comparison of Rhythmic Responsiveness in Normal and Educable Mentally Retarded Children." Dissertation Abstracts International A 38:6 (December, 1977): 3354A.

- Kerlinger, F. N. Foundations of Behavioral Research. 2nd ed. New York: Holt, Rinehart and Winston, Inc., 1973.
- Kirk, R. E. Experimental Design Procedures for the Behavioral Sciences. Belmont, California: Brooks/Cole Publishing Co., 1968.
- Korson, F. "Music Therapy for Children with Muscular Dystrophy." In Music Therapy 1957. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1958.
- Kuhn, T. S. The Structure of Scientific Revolution. Chicago: University of Chicago Press, 1962.
- Larson, B. A. "A Comparison of Singing Range of Mentally Retarded and Normal Children with Published Songbooks Used in Singing Activities." Journal of Music Therapy 14 (Fall, 1977): 139-143.
- Lathom, W., Edson, S., and Toombs, M. R. "A Coordinated Speech Therapy and Music Therapy Programs." Journal of Music Therapy (Winter, 1965): 1-8.
- Lehrer-Carle, I. "Group Dynamics as Applied to the Use of Music with Schizophrenic Adolescents." British Journal of Music Therapy 4 (Summer, 1973): 10.
- Lienhard, M. "Factors Relevant to the Rhythmic Perception of a Group of Mentally Retarded Children." Journal of Music Therapy 13 (Summer, 1976): 58-65.
- Ludwig, A. J., and Tyson, F. "A Song for Michael." Journal of Music Therapy 6 (Fall, 1969): 82-86.
- Madsen, C. K., and Madsen, C. H. "Music as a Behavior Modification Technique with Juvenile Delinquent." Journal of Music Therapy

- 5 (Fall, 1968): 72-76.
- Mahlberg, M. "Music Therapy in the Treatment of an Autistic Child." Journal of Music Therapy 10 (Winter, 1973): 189-193.
- Maranto, C. D. "An Analysis of Unpublished Research Reports in Music Therapy." New Orleans, 1979. (Mimeographed.)
- Martin, N., and Kilgour, W. W. "Music Therapy in Treatment of Chronically Regressed Geriatric Patients." Osteopath Annals 6 (April, 1978): 71-73.
- McCarty, B. C., McElfresh, C. T., Rice, S. V., and Wilson, S. J. "The Effects of Contingent Background Music on Inappropriate Bus Behavior." Journal of Music Therapy 15 (Fall, 1978): 50-56.
- McCarty, H. "Use of the Draw-A-Person Test to Evaluate a Dance Therapy Program." Journal of Music Therapy 10 (Fall, 1973): 144-155.
- Meseck, K. "An Evaluation of Music Therapy with Geriatric Patients." Journal Canadian Association for Music Therapy 16 (Winter, 1979): 172-179.
- Metzler, R. "The Use of Music as a Reinforcer to Increase Imitative Behavior in Severely and Profoundly Retarded Female Residents." Journal of Music Therapy 11 (Summer, 1974): 197-210.
- Michel, D. E. "Contemporary Research Projects in Progress Within the Long Range Design Framework - A Review of Trends." In Music Therapy 1953. Edited by Mariana Bing. Lawrence, Kansas: National Association for Music Therapy, 1954.
- Michel, D. E., and Martin, D. "Music and Self-Esteem Research with Disadvantaged, Problem Boys in an Elementary School." Journal

- of Music Therapy 7 (Winter, 1970): 120-127.
- Michel, D. E. "Music Therapy in Cleft Palate Disorders." In Music Therapy 1961. Edited by E. H. Schneider. Lawrence, Kansas: National Association for Music Therapy, 1962.
- Miller, D. M., Dorrow, L. G., and Greer, R. D. "The Contingent Use of Music and Art for Improving Arithmetic Scores." Journal of Music Therapy 11 (Summer, 1974): 57-64.
- Mitchell, C. G. "Bedtime Music for Psychotic Children. Nursing Mirror 122 (1966): 452.
- Music Therapy 1951. Book of Proceedings of the National Association for Music Therapy. Chicago, Ill.: 1950.
- Myers, E. "The Effect of Music on Retention in a Paired-Associate Task with EMR Children." Journal of Music Therapy 16 (Winter, 1979): 190-198.
- Nebe, H. J. "Music Therapy - Its Function in Supporting the Rehabilitation of the Handicapped." Journal of Music Therapy 8 (Spring, 1971): 3-11.
- Nie, N., Hall, C., Jenkins, J., Steinbrenner, K., and Bent, D. Statistical Package for the Social Sciences. New York: McGraw-Hill Book Company, 1975.
- Nordholm, H. "Music for the Cerebral Palsied Child." In Music Therapy 1953. Edited by Mariana Bing. Lawrence, Kansas: National Association for Music Therapy, 1954.
- O'Connell, T. S. "The Musical Life of an Autistic Boy." Journal of Autism and Childhood Schizophrenia 4 (Winter, 1974): 223-229.

- Ogden, J. "Application of Music to the Treatment of Children Suffering Functional Disorders of Speech and Language." Proceedings, Second National Conference, Australian Music Therapy Association (1976): 23-28.
- Oke, D. "Developing Music Stimulation Programmes in Long Term Geriatric Settings." Bulletin, Australian Music Therapy Association 2 (1979): 5-9.
- Palmer, M. D. "Music Therapy in a Comprehensive Program of Treatment and Rehabilitation for the Geriatric Resident." Journal of Music Therapy 14 (Winter, 1977): 190-197.
- Patterson, W. "Our Own Thing." Journal of Music Therapy 9 (Fall, 1972): 119-122.
- Pedleton, L. R., and Tasto, D. L. "Effects of Metronome - Conditioned Relaxation, Metronome - Induced Relaxation and Progressive Muscle Relaxation on Insomnia." Behavior Research and Therapy 14 (1976): 165-166.
- Pendergrass, P. E. "Therapy Through Service to Others." Journal of Music Therapy 2 (Fall, 1965): 86-89.
- Pepinsky, A. "Application and Mis-Application of Research Techniques in Music Therapy." In Music Therapy 1952. Edited by Esther G. Gilliland. Lawrence, Kansas: National Association for Music Therapy, 1954.
- _____. "Introductory Remarks." In Music Therapy 1954. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1955.
- _____. "Research Session Introductory Remarks." In Music Therapy

1955. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1956.
- Peters, M. "A Comparison of the Musical Sensitivity of Mongoloid and Normal Children." Journal of Music Therapy 7 (Winter, 1970): 113-123.
- Powell, L. "Music with Emotionally Handicapped Teenagers." Proceedings, Fourth Annual Conference, Australian Music Therapy Association, 1978.
- Ragland, Z., and Apprey, M. "Community Music Therapy with Adolescents." Journal of Music Therapy 11 (Fall, 1974): 47-55.
- Reardon, D., and Bell, G. "Effects of Sedative and Stimulative Music on Activity Levels of Severely Retarded Boys." American Journal of Mental Deficiency 75 (1970): 156-159.
- Reid, D. H., Hill, B. K., Rawers, R. J., and Montegar, C. A. "The Use of Contingent Music in Teaching Social Skills to a Nonverbal Hyperactive Boy." Journal of Music Therapy 12 (Spring, 1975): 2-17.
- Riegler, J. "Comparison of a Reality Orientation Program for Geriatric Patients With and Without Music." Journal of Music Therapy 17 (Spring, 1980): 26-33.
- _____. "The Use of Music in a Group Sensory Training Program for Regressed Geriatric Patients." Master's thesis, Loyola University, 1981.
- Ritschl, C., Mongrella, J., and Presbie, R. "Group Time-Out from Rock and Roll Music and Out-of-Seat Behavior of Handicapped Children While Riding a School Bus." Psychological Report 31 (December,

- 1972): 967-973.
- Rubin, B. "Handbells in Therapy." Journal of Music Therapy 13 (Spring, 1976): 49-52.
- Saperston, B. "The Use of Music in Establishing Communication with an Autistic Mentally Retarded Child." Journal of Music Therapy 10 (Winter, 1973): 184-188.
- Schneider, E. H. "Relationship Between Musical Experience and Certain Aspects of Cerebral Palsied Children's Performance on Selected Tasks." In Music Therapy 1956. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1957.
- Schoenberger, Leonard. "Music Therapy and Vocational Achievement." Journal of Music Therapy 8 (Spring, 1971): 12-25.
- Schoenfeld, L. "Effects of Auditory Stimulation on the Performance of Brain-Injured and Familial Retardates." Perceptual and Motor Skills 31 (1970): 139-144.
- Segenthaler, M. "Work with ESS Patients." British Journal of Music Therapy 10 (September, 1979): 2-6.
- Seybold, C. D. "The Value and Use of Music Activities in the Treatment of Speech Delayed Children." Journal of Music Therapy 8 (Fall, 1971): 102-110.
- Shatin, L. "The Application of Rhythmic Music Stimuli to Long-Term Schizophrenic Patients." In Music Therapy 1957. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1958.

- Sheppard, T. "Relationship Therapy Through Music with Maladjusted Boys." British Journal of Music Therapy 8 (Summer, 1977): 6-10.
- Slaughter, F. E. "Effects of Musical Stimuli on Normal and Abnormal Subjects as Indicated by Pupillary Reflexes." In Music Therapy 1953. Edited by Mariana Bing. Lawrence, Kansas: National Association for Music Therapy, 1954.
- Slowo, N. "Music Therapy for Children with Special Needs." Proceedings, Second National Conference, Australian Music Therapy Association. (August, 1976): 45-49.
- Smith, S. M. "Using Music Therapy with Short-Term Alcoholic and Psychiatric Patients." Hospital and Community Psychiatry 26 (July, 1975): 420-421.
- Sommer, D. L. "Music Therapy Without Music." Bulletin of the National Association for Music Therapy 10 (Summer, 1961): 3.
- _____. "Music Therapy Without Music." Bulletin of the National Association for Music Therapy 10 (May, 1961): 4-12.
- Sparks, R. W., and Holland, A. L. "Method: Melodic Intonation Therapy for Aphasia." Journal of Speech and Hearing Disorders 41 (August, 1976): 287-297.
- Staples, S. M. "A Paired-Associates Learning Task Utilizing Music as the Mediator: An Exploratory Study." Journal of Music Therapy 5 (June, 1968): 53-57.
- Steele, A. L. "Effects of Social Reinforcement on the Musical

- Preference of Mentally Retarded Children." Journal of Music Therapy 4 (June, 1967): 57-62.
- Stern, V. "They Shall Have Music." Volta Review 77 (1975): 495-500.
- Sternlicht, M., Deutsch, M., and Siegel, L. "Influence of Musical Stimulation Upon the Functioning of Institutionalized Retardates." Psychiatric Quarterly Supplement 41 (1967, pt. 2): 323-329.
- Stevens, E., and Clark, F. "Music Therapy in the Treatment of Autistic Children." Journal of Music Therapy 6 (Winter, 1969): 98-104.
- Strathdee, H. "Music for Hearing Impaired Children in an Integrating Setting." Bulletin, Australian Music Therapy 3 (February, 1980): 10-12.
- Talkington, L., and Hall, S. "A Musical Application of Premack's Hypothesis to Low Verbal Retardates." Journal of Music Therapy 7 (Fall, 1970): 95-99.
- Taylor, D. "Expressive Emphasis in the Treatment of Intropunitive Behavior." Journal of Music Therapy 6 (Summer, 1969): 41-43.
- van Breda, H. "Developing Mentally Handicapped Children Through Movement Activities." The Australian Music Therapy Association Bulletin 3 (March, 1980): 13-16.
- Wadson, H. "Combining Expressive Therapies." American Journal of Art Therapy 15 (1976): 43-46.
- Wardle, M. "Music Therapy in a Women's Prison, Part 1: The Old Prison." British Journal of Music Therapy 10 (February, 1979): 11-14.

- Wasserman, N. M. "Music Therapy for the Emotionally Disturbed in a Private Hospital." Journal of Music Therapy 9 (Summer, 1972): 99-104.
- Watts, T. D. "Understanding the Elderly Alcoholic." British Journal of Music Therapy 11 (Autumn, 1980): 10-15.
- Weigl, V. "Functional Music with Cerebral Palsied Children." In Music Therapy 1954. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1955.
- Wells, A. "Values and Problems of Patient Performances." In Music Therapy 1957. Edited by E. Thayer Gaston. Lawrence, Kansas: National Association for Music Therapy, 1958.
- Wilke, M. "The Disc Jockey Jamboree." In Music Therapy 1960. Edited by E. H. Schneider. Lawrence, Kansas: National Association for Music Therapy, 1961.
- Wilson, C. V. "The Use of Rock Music as a Reward in Behavior Therapy with Children." Journal of Music Therapy 13 (Spring, 1976): 40-47.
- Wolfe, D. E. "Pain Rehabilitation and Music Therapy." Journal of Music Therapy 15 (Winter, 1978): 162-178.
- Yamadori, A., Osumi, Y., Masuhara, S., and Okubo, M. "Preservation of Singing in Broca's Aphasia." Journal of Neurology, Neurosurgery, and Psychiatry 40 (March, 1977): 221-224.
- Young, W. T. "Efficacy of a Self-Help Program in Music for Disadvantaged Preschools." Journal of Research in Music Education

23 (Summer, 1975): 99-108.

Zenatti, A. "Melodic Memory Tests: A Comparison of Normal Children
and Mental Defectives." Journal of Research in Music Education

23 (September, 1975): 41-52.

VITA

Anthony Arthur Decuir was born February 7, 1948, in New Orleans, Louisiana. In May of 1970, he received a Bachelor of Science degree in music from Xavier University in New Orleans. In that same year, he received a Bachelor of Music Therapy degree from Loyola University in New Orleans. Mr. Decuir entered the master's degree program in music therapy at Loyola in 1973. The degree was completed in December of 1975. In the spring of 1977, Mr. Decuir began work toward the doctor of philosophy degree at Louisiana State University; he was admitted to candidacy for the degree in the summer of 1980. His doctoral dissertation was entitled, "An Instructional Sequence in Statistics and Experimental Design for Graduate Music Therapy Students."

Mr. Decuir's professional employment career began in the summer of 1970 with his clinical internship in music therapy at Central Louisiana State Hospital, a public psychiatric facility in Alexandria, Louisiana. Concomitantly with his internship, Mr. Decuir was employed as a music therapist at the Pinecrest State School, a residential treatment facility for the mentally retarded. In 1970, Mr. Decuir completed his internship and was immediately drafted into the United States Army. In the spring of 1973, Mr. Decuir became a co-therapist at the community mental health center of the Touro Infirmary in New Orleans. Also at this time, Mr. Decuir was a graduate assistant at Loyola.

In 1975, Mr. Decuir became an instructor in the Music Therapy Department at Loyola University and in 1980, he was awarded tenure and the rank of associate professor. During his employment at Loyola, he also served as a lecturer at Delgado College.

Since his return to professional life after discharge from the Army, Mr. Decuir has been active professionally. He is a member of the research committee, the Assembly of Delegates, and the Executive Board of the National Association for Music Therapy. Mr. Decuir has published the following works: "Vocal Responses of Mentally Retarded Subjects to Four Musical Instruments," Individual Study Program in Music Therapy, "A Profile for a Sample of Learning Disabled Children and Adolescents: A Pilot Study," "A Survey of Clinical Practice in Music Therapy Part I: The Institutions in Which Music Therapists Work and Personal Data," "A Survey of Clinical Practice in Music Therapy Part II: Clinical Practice, Educational, and Clinical Training." Mr. Decuir has also published articles entitled "An Analysis of Visual and Auditory Rhythmic Perception Abilities of Piano Majors," and "Entry Level Skills of Music Therapy Students." Along with these publications, Mr. Decuir has made annual presentations to the National Association for Music Therapy conferences since 1973.

Mr. Decuir is married to the former Ms. Saraphine Tregre and they have two children, Anthony, Jr. and Patrice.

EXAMINATION AND THESIS REPORT

Candidate: Anthony Arthur Decuir

Major Field: Music Education

Title of Thesis: An Instructional Sequence in Experimental Design and Statistics
for Graduate Music Therapy Students

Approved:

Robert Shambaugh
Major Professor and Chairman

Sean P. McGlynn
Dean of the Graduate School

EXAMINING COMMITTEE:

John R. Paul

Miriam Halkman

Paul Louis Abel

Walter McKenzie

Date of Examination:

16 November 1981
